INNOGROW Project

A1.1 “Impact analysis report on main new technologies’ for rural economy SMEs”

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1 Introduction

1.1 The INNOGROW project

The "Regional policies for innovation driven competitiveness and growth of rural SMEs – INNOGROW" is an Interreg Europe project aiming to improve partners' policies on rural economy SMEs competitiveness as regards the integration of new production technologies and business models that lead to innovative products. The project will promote the adoption of innovation by rural economy SMEs, through sharing practices / experiences between regions and actors relevant to rural economy SMEs' competitiveness, and integrating lessons learnt into regional policies and action plans.

European regions have an essential role to play in shaping and implementing policies for economic development. The economic and environmental challenges faced by rural economy SMEs are the ones INNOGROW partners focus on, and address with improved policies. Research results and the European Commission agree on the necessity to foster innovation adoption by rural economy SMEs, with the purpose to increase their productivity, competitiveness and internationalisation. The INNOGROW project idea has thus been developed to address these challenges through interregional cooperation, exchange and valorisation of good practices of regions, with the aim to influence policies both at regional and national level for improving the competitiveness of rural economy SMEs.

Territorial capacity building and policy innovation involving all regional actors are critical factors for promoting the diffusion of innovations, to maintain and strengthen SMEs' competitiveness and consequently regions' growth. Regions in rural areas have to provide incentives to promote the adoption of technological innovations, such as organic farming, functional food, crop resistance systems, selective breeding and feeding processes to boost livestock resistance to local conditions. At the management level, incentives need to be provided for mixed production of crops and livestock products, and new business models and coalitions that lead to innovative business ideas.

1.2 Report purpose and scope

This report is the main output of Activity 1.1 of the INNOGROW project, which constitutes the forth part of the activity 1.1 entitled "*Impact analysis report on main new technologies' for rural economy SMEs*". This report builds upon the results of the previous parts of this activity, i.e. the methodology

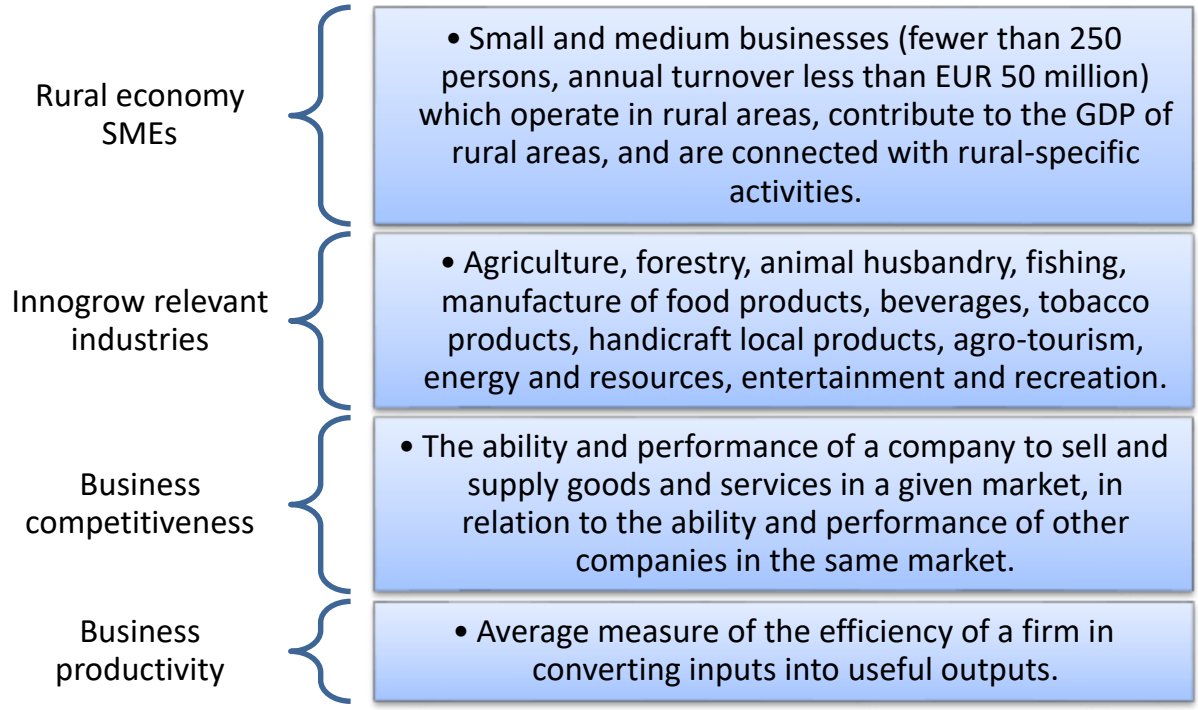
for collecting and analysing evidence, the desk research report (1st stage), and the cases collected from INNOGROW partners, which deal with on the identification of impact of new technologies on the competitiveness and productivity of rural economy SMEs.

The current report aims to present the impact of 12 new technologies suitable for rural economy SMEs, to identify the enablers and barriers for adopting each technology to support rural economy, and to provide policy recommendations useful for the public authorities on how to establish favourable conditions and offer incentives to SMEs for integrating innovative solutions. More particularly, the report provides:

- A description of the analysis methodology, including desk research and cases collection and analysis.
- An overview of the 12 selected new technologies, providing definitions and describing the innovative aspects, the current situation in the market, the impact and benefits for SMEs, and the inhibitors encountered by SMEs.
- A detailed presentation of 14 cases collected by partners and the main findings regarding the impact of the new technologies on the competitiveness and productivity of the particular SMEs in the partners' countries.
- Conclusions and policy recommendations for public authorities of the partners' territories, based on a matrix presenting the selected new technologies, areas of impact, regional conditions, enablers and barriers, to demonstrate under which conditions each of the new technologies works best.

1.3 Definitions

The following chart presents the key concepts and definitions related to the impact analysis report:



2 Analysis Methodology

The methodological approach to analyse the impact of the selected new technologies on the competitiveness and productivity of rural economy SMEs was based on desk research and field research evidence on a case study basis.

Desk research was the primary mean of information gathering, targeting to produce a knowledge base about the main new disruptive technologies that have considerable impact on the competitiveness and productivity of rural economy SMEs. Evidence was gathered from previous related work such as studies, surveys, industry reports, EU projects, and other available data sources such as databases and online resources.

Structured interviews were conducted, in the form of an online questionnaire, to identify specific cases of new technologies adoption by rural economy SMEs in the partners' countries, and provide insights on experience-based views and opinions referring to the effectiveness and impact of the identified cases, as well as on the local conditions, enablers and barriers to the adoption of particular technological innovations. The experience gained in these cases was used to predict the economic, socio-economic and environmental effects associated with the proposed action / technology adoption elsewhere.

2.1 Desk research scope

To collect the most useful and relevant evidence to the research objectives, a targeted approach was followed based on the following constraints:

1. The gathered evidence was based primarily on research from the countries represented in the project consortium (Greece, United Kingdom, Italy, Hungary, Slovenia, Bulgaria, Czech Republic and Latvia), and secondarily from other EU member states.
2. Only recent resources and research studies that have been implemented during the last ten years were taken into account.
3. Data collection was focused on new / innovative technologies that have been adopted by SMEs, which operate in rural areas, contribute to the GDP of rural area, are connected with

rural-specific activities, and are driven by or based on natural capital / rural environment. The technologies analysed are the following:

Innovative production technologies	Technologies supporting products' distribution	Technologies supporting product's safety
• Organic farming, Renewable energy • Precision agriculture • Crop resistance systems • Novel crop • Functional foods	• E-platforms for products' promotion and exports • Online orders and delivery tools • Food traceability systems as marketing tool	• Smart meters and IoT • Internal products traceability systems and traceability as a supply chain management tool • Selective breeding processes

In principal, each technology description in Section 3 is divided into the following parts:

Definition & innovative aspects: brief description of the technology and the most recent innovations in the field.

Current situation / nature of the market / industry: overview of the industry, prices for technology's adoption, and drivers in the market.

Impact / benefits for the SME: brief presentation of the main benefits for the SMEs associated with the integration of the technology.

Inhibitors for adoption: brief presentation of the main barriers reported by rural economy SMEs as regards the integration of the technology.

2.2 Field research analysis

The impact of technology adoption on SME's competitiveness and productivity

This study examines the impacts of economic and socio-economic factors on the adoption of new technologies in order to increase SMEs' competitiveness and productivity among the countries represented in the partnership (Greece, United Kingdom, Italy, Hungary, Slovenia, Bulgaria, Czech Republic and Latvia). A structured online questionnaire (Annex A) was designed to collect evidence and draw on the expertise of target respondents related to cases of innovative technology adoption

in rural areas. To reach the aim of this study, the questionnaire is structured into three main sections: Section A Case identity, Section B Needs, enablers and barriers of the case, and Section C Impact and transferability of the case. Statistical and econometric techniques have been used to analyse the data. Descriptive statistics are applied to describe the case identity in Section A. Section B is analysed using Chi-Square Test and Mann-Whitney U Test. For Section C, Discriminant Analysis is used to investigate the difference between two or more groups of cases with respect to factors influencing the adoption of new technologies.

2.2.1 Section A: Case Identity

We provide an overview of the characteristics of rural SMEs among eight countries, and highlight the potential relationship among the variables to investigate innovative technologies impact on rural economy SMEs competitiveness and productivity. We also summarise some key variables and information contributing to the adoption of new technology such as the country of the cases, the core industry, the number of employees, annual turnover, the type of technology adapted and so on. Basic descriptive data such as frequencies and percentages are used to describe the variables.

The responses, from mainly owners or directors of companies, were collected from eight countries by nine partners as shown in Table 1. Czech Republic contributes to the highest number of firm responses with 20 returns, followed by Slovenia (16), Latvia (10), and the UK (8). Greece and Hungary have only one response that completed all questions. As the number of questionnaire responses per country is small, it is therefore not possible to analyse the impact of new technology adoption the country level.

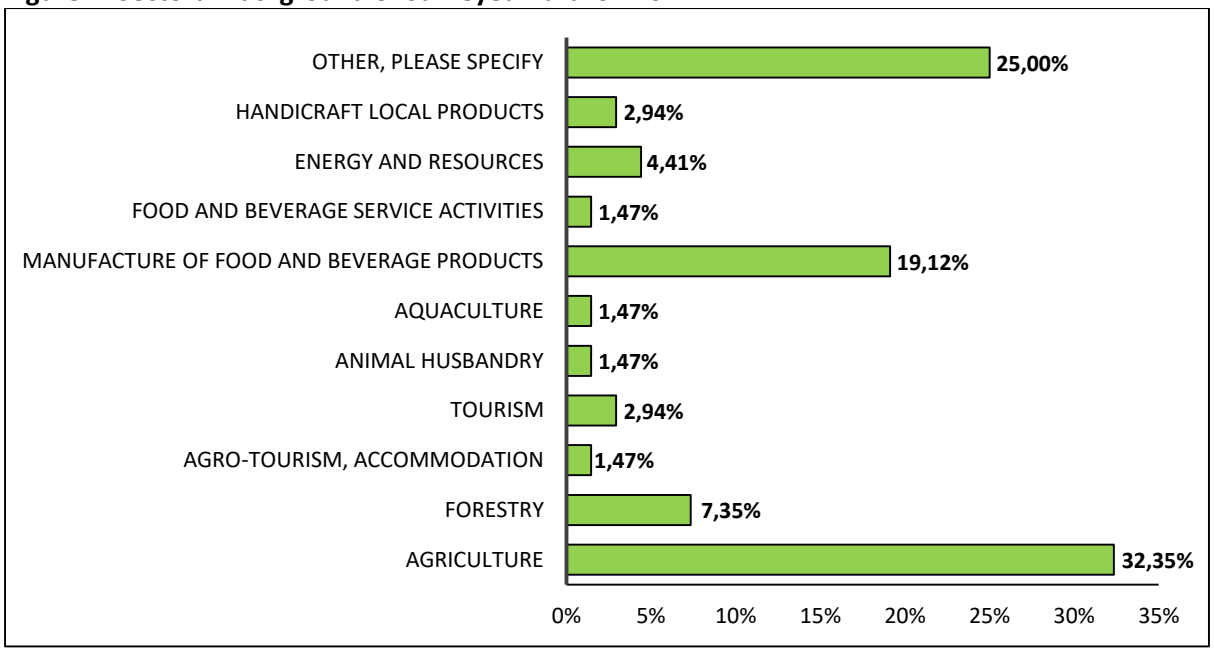
Table 1: Questionnaire Responses by Country

Partner	Country	Number of questionnaire responses (Country identified)	Number of questionnaire responses that completed all questions	%
ZPR	Latvia	10	10	18.87
SZREDA	Bulgaria	5	5	9.43
RRAPK	Czech Republic	20	13	24.53
BSC	Slovenia	16	9	16.98
UNEW	UK	8	8	15.09
CoC – Molise	Italy	4	4	7.55
FLA	Italy	2	2	3.77
RoT	Greece	2	1	1.89
PANOV	Hungary	1	1	1.89
Total	EU	68	53	100

Source: INNOGROW survey (2016)

Rural SMEs in this study mainly operate in agriculture with 32.4 per cent followed by Others (e.g. information technology, water management, construction - 25%), Manufacture of food and beverage products (19.1%) and forestry (7.4%) (Figure 1). The SMEs have been grouped into three categories, namely primary, secondary and tertiary sectors which are useful for the analysis. Agriculture, forestry, Animal husbandry and aquaculture are grouped as the primary industry. The secondary sector includes manufacture of food and beverage products, energy and resources. Tourism and Others are here specified as the tertiary sector.

Figure 1: Sectoral Background of Surveyed Rural SMEs



Source: INNOGROW survey (2016)

Tables 2 and 3 show the number of employees and the amount of annual turnover of rural SMEs across the eight countries respectively. Approximately 57.4 per cent of the rural SMEs have less than 10 employees followed by 10-49 employees (26.5%) and 50-249 employees (14.7%) respectively. Only one firm has 250 employees or more. For turnover, the majority of rural SMEs register less than 2 million EUR per annum (69.7%), and only 21.2 per cent and 9.1 per cent register 2-10 and 10-50 million EUR respectively. The survey also reveals that no firms report an annual turnover of more than 50 million EUR.

Table 2: The Number of Employees within the cases

Number of employees	Number of Rural SMEs	%
Less than 10 employees	39	57.35
10-49 employees	18	26.47
50-249 employees	10	14.71
250 employees and more	1	1.47
Total	68	100.00

Source: INNOGROW survey (2016)

Table 3: The Annual Turnover of Rural SMEs

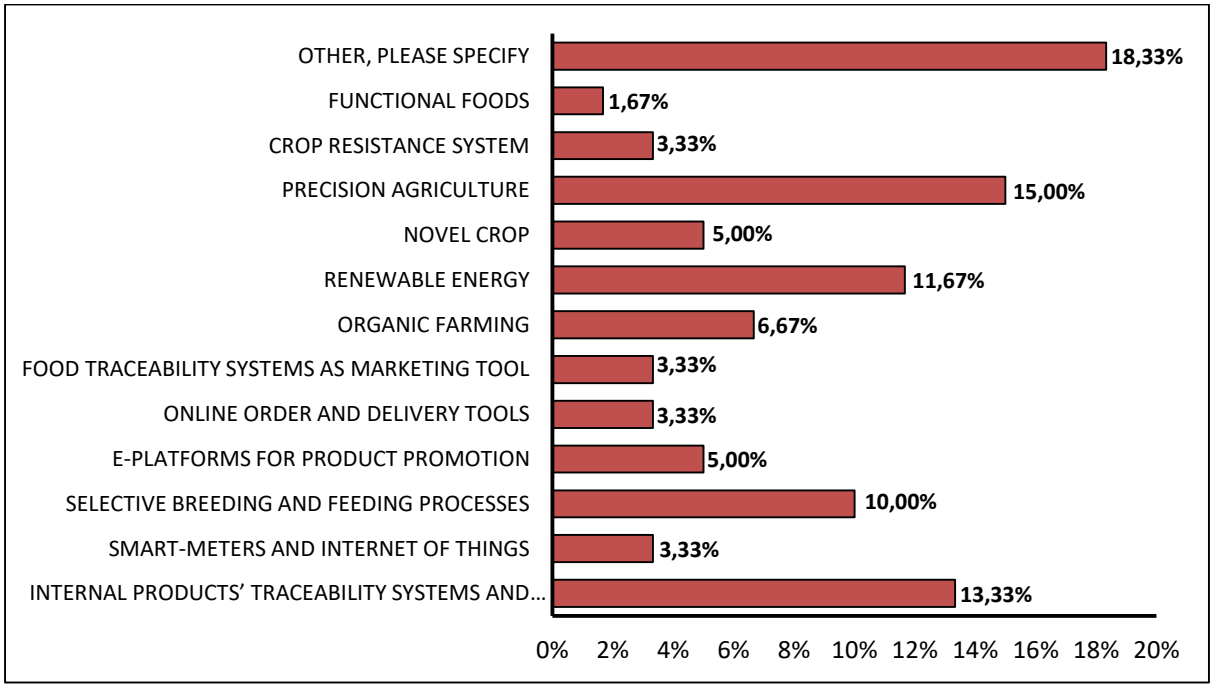
The amount of Turnover (EUR)	Number of Rural SMEs	%
Less than 2 million	46	69.70
2 – 10 million	14	21.21
10 – 50 million	6	9.09
More than 50 million	0	0.00
Total	66	100.00

Source: INNOGROW survey (2016)

To study the impacts of technology adoption on rural SMEs' competiveness and productivity, it is important to understand what type of technology is adopted by firms (see Figure 2). Approximately 18 per cent of rural firms highlight Other types of technology, with examples including environmental monitoring network, harvesting technology, and innovative vender machines. Precision agriculture is the second popular technology adopted by sampled firms with 15 per cent. Around 13 per cent and 12 per cent of the firms adopt traceability systems and renewable energy respectively. Only 1.7 per cent of the surveyed firms use functional food as an innovative technology.

These types of innovative technologies have been adopted in different years. Table 4 presents which year firms adopted their new technologies. Rural SMEs are more likely to start implementing the new technology recently from year 2012 to 2016. The highest proportion of the firms adopted new technology in year 2016 with 13.3 per cent followed by year 2015 and 2012 (11.7%), and year 2010 and 2005 (10%).

Figure 2: The Type of Technology adopted by Rural SMEs



Source: INNOGROW survey (2016)

Table 4: The year in which the technology was adopted by Rural SMEs

Year	The number of rural SMEs	%
2016	8	13.33%
2015	7	11.67%
2014	5	8.33%
2013	3	5.00%
2012	7	11.67%
2011	5	8.33%
2010	6	10.00%
2009	4	6.67%
2008	2	3.33%
2007	2	3.33%
2006	5	8.33%
2005	6	10.00%
Total	60	100%

Source: INNOGROW survey (2016)

The adoption of innovative technology may results in an increase in rural SMEs' competitiveness and productivity. It can help rural SMEs to access to new domestic and international markets, to increase employment in rural areas or to increase firm profitability. To improve competitiveness and

productivity, we therefore need to understand the main objectives of rural SMEs for adopting the new technology, the enablers or success factors that support rural SMEs to adopt the new technology, as well as the difficulties or barriers encountered by rural SMEs during the integration of new technology.

2.2.2 Section B: Needs, Enablers and Barriers for Adoption

The Main Needs/Objectives of Rural SMEs to adopt the New Technology

In this section, we apply the Chi-square (χ^2) statistic to analyse group differences when the dependent variable is measured at a nominal (categorical) level [1]. The χ^2 statistic is robust with respect to the distribution of the data like all non-parametric statistics. Specifically, it does not require equality of variances among the study groups or homoscedasticity in the data. It permits evaluation of both dichotomous independent variables, and of multiple group studies [2]. To draw out some of the key features of the main needs/objectives which lead rural SMEs to adopt the new technology, the questionnaires are designed to give answers at the categorical level, so the χ^2 statistic can be appropriately used. The dependent variables are here classified into 3 groups: 1) job generation and no job generation, 2) access to new market and no access to new market, and 3) firm profitability and no firm profitability. Table 5 shows the key features of the main objectives for rural SMEs to implement the new technology, comparing firms who said the new technology had impacted positively on their numbers of employees and those where there was no positive impact on numbers . The results show no statistically significant differences in objectives for adoption in terms of derived impacts on job generation. The main reason for both groups to adopt the new technology is *access to new markets/identified market opportunity,* applying to 57.1 per cent of firms that had had job generation and 48.6% that had no job generation. In firms where new technology had led to an increase in employees, important needs/objectives related to *responding to competition*, *improving environmental impact/resource efficiency* and *personal interest in the new technology*.

Table 5: The Main Needs/Objectives for Rural SMEs to adopt the New Technology by Job Generation

Main Needs/Objectives	Number of Businesses		Total
	No job generation	job generation	
Reduce production costs	13 (35.1%)	5 (35.7%)	18 (35.3%)
Respond to competition	13 (35.1%)	7 (50.0%)	20 (39.2%)
Access new markets/ identified market opportunity	18 (48.6%)	8 (57.1%)	26 (49.0%)
Increase profitability, revenue	16 (43.2%)	6 (42.9%)	22 (43.1%)
Satisfy customers' needs	17 (45.9%)	5 (35.7%)	22 (43.1%)
Positive environmental impact/ resource efficiency	15 (40.5%)	7 (50.0%)	22 (43.1%)
Personal interest in the new technology	17 (45.9%)	7 (50.0%)	24 (47.1%)
Meet legislative/policy changes	6 (16.2%)	1 (7.1%)	7 (13.7%)
Other	0 (0.0%)	1 (7.1%)	1 (2.0%)
Total	36	15	51

Table 6 compares objectives for technology uptake between firms that said new technology had impacted positively on their ability to access new markets and those where there had been no positive impact. There are statistically significantly differences between the groups in terms of their objectives to *access new markets/identified market opportunity* and *satisfy customers' needs*. Approximately 76 per cent of rural SMEs with improved ability to access markets aimed to adopt the new technology for *Access new markets/identified market opportunity* compared to only 13 per cent of rural SMEs without improved ability. A higher percentage of Rural SMEs with improved ability to access markets also aimed to adopt the new technology to *satisfy customers' need*. Other main objectives for SMEs that had improved ability access new markets are *Positive environmental impact/ resource efficiency* (48.3%) and *Personal interest in the new technology* (48.3%).

Table 6: The Main Needs/Objectives for Rural SMEs to adopt the new technology by whether technology enabled accessing a new market

Main Needs/Objectives	Number of Businesses		Total
	No access to new market	Access to new market	
Reduce production costs	10 (43.5%)	8 (27.6%)	18 (34.6%)
Respond to competition	8 (34.8%)	13 (44.8%)	21 (40.4%)
Access new markets/ identified market opportunity	3 (13.0%)	22 (75.9%)	25 (48.1%)
Increase profitability, revenue	9 (39.1%)	13 (44.8%)	22 (42.3%)
Satisfy customers' needs	6 (26.1%)	17 (58.6%)	23 (44.2%)
Positive environmental impact/ resource efficiency	8 (34.8%)	14 (48.3%)	22 (42.3%)
Personal interest in the new technology	10 (43.5%)	14 (48.3%)	24 (46.2%)
Meet legislative/policy changes	2 (8.7%)	5 (17.2%)	7 (13.5%)
Other	0 (0.0%)	1 (3.4%)	1 (1.9%)
Total	23	30	53

Shading denotes statistically significant response using Chi-square test (X^2-test: $p<0.05$)

For impacts on firm profitability as a result of new technology, the main needs/objectives of rural firms to adopt the new technology are presented in Table 7. *Personal interest in the new technology* is the only objective where there is a significantly difference between firms that experienced an impact on profitability. Approximately 56 per cent of rural SMEs that adopt the new technology for *Personal interest in the new technology* had experienced a positive impact on profitability, compared to only 28 per cent for rural SME without profitability.

Table 7: The Main Needs/Objectives for Rural SMEs to adopt the New Technology by Firm Profitability

Main Needs/Objectives	Number of Businesses		Total
	No firm profitability	Firm profitability	
Reduce production costs	4 (22.2%)	14 (43.8%)	18 (36.0%)
Respond to competition	7 (38.9%)	13 (40.6%)	20 (40.0%)
Access new markets/ identified market opportunity	8 (44.4%)	15 (46.9%)	23 (46.0%)
Increase profitability, revenue	5 (27.8%)	16 (50.0%)	21 (42.0%)
Satisfy customers' needs	10 (55.6%)	12 (37.5%)	22 (44.0%)
Positive environmental impact/ resource efficiency	7 (38.9%)	18 (40.6%)	23 (40.0%)
Personal interest in the new technology	5 (27.8%)	18 (56.3%)	23 (46.0%)
Meet legislative/policy changes	4 (22.2%)	2 (6.3%)	6 (12.0%)

Shading denotes statistically significant response using Chi-square test (X^2-test: $p<0.05$)

The Enablers of Rural SMEs for supporting the Adoption of the New Technology

In this section, the χ^2 statistic is applied to find key enablers, local conditions and success factors of rural firms that support the adoption of the new technology. The 3 groups of technology impacts are again used to compare these features: 1) job generation and no job generation, 2) access to new market and no access to new market, and 3) firm profitability and no firm profitability.

A key finding of interest to enablers of rural firms for supporting the new technology, is that a higher level (40.0%) of firms that experienced job generation from adoption identified *Private, external funding (bank, investor, venture capital)* as supporting their adoption of the new technology, compared to firms without job generation (13.9%) (Table 8). Both firms with and without job generation identify *Internal capital (from firm and its owners)* as supporting their new technologies.

Table 8: Enablers of Rural SMEs for supporting the Adoption of the New Technology – Job Generation

Enablers of Rural SMEs for supporting the Adoption of the New Technology	Number of Businesses		Total
	No job generation	job generation	
Public funding	16 (44.4%)	4 (26.7%)	20 (39.2%)
Internal capital (from firm and its owners)	28 (77.8%)	8 (53.3%)	36 (70.6%)
Private, external funding (bank, investor, venture capital)	5 (13.9%)	6 (40.0%)	11 (21.6%)
Market potential	10 (27.8%)	3 (20.0%)	13 (25.5%)
Existing employees with relevant knowledge and skills	5 (13.9%)	4 (26.7%)	9 (17.6%)
Hiring new employees with relevant knowledge and skills	3 (8.3%0	2 (13.3%)	5 (9.8%)
Collaboration with other businesses	8 (22.2%)	4 (26.7%)	12 (23.5%)
Adversary service	2 (5.6%)	3 (20.0%)	5 (9.8%)
Other	3 (8.3%)	1 (6.7%)	4 (7.8%)
Total	36	15	51

Shading denotes statistically significant response using Chi-square test (X^2-test: $p<0.05$).

For access to new markets, Table 9 shows that rural SMEs with improved ability to access markets are more likely to identify the importance of *Existing employees with relevant knowledge and skills* (30.0%) compared to the firms without improved ability (4.3%). Additionally, *Advisory services* are statistically more significant for the firms that had experienced improved ability access to new markets. Both groups of firms identify the importance of *Internal capital (from firm and its owners)* to support the adoption of new technology.

Table 9: The Enablers of Rural SMEs for supporting the Adoption of New Technology – Access to New Market

Enablers of Rural SMEs for supporting the Adoption of the New Technology	Number of Businesses		Total
	No access to new market	Access to new market	
Public funding	6 (26.1%)	14 (46.7%)	20 (37.7%)
Internal capital (from firm and its owners)	17 (73.9%)	20 (66.7%)	37 (69.8%)
Private, external funding (bank, investor, venture capital)	3 (13.0%)	8 (26.7%)	11 (20.8%)
Market potential	3 (13.0%)	10 (33.3%)	13 (24.5%)
Existing employees with relevant knowledge and skills	1 (4.3%)	9 (30.0%)	10 (18.9%)
Hiring new employees with relevant knowledge and skills	2 (8.7%)	4 (13.3%)	6 (11.3%)
Collaboration with other businesses	4 (17.4%)	8 (26.7%)	12 (22.6%)
Advisory service	0 (0.0%)	6 (20.0%)	6 (11.3%)
Other	3 (13.0%)	1 (3.3%)	4 (7.5%)
Total	23	30	53

Shading denotes statistically significant response using Chi-square test (X^2-test: $p<0.05$).

When we compare enablers between rural firms according to their improved profitability as a result of adoption, there are no statistically significant differences between the two groups (Table 10). Both groups are more likely to identify *Internal capital (from firm and its owners)* and *Public funding* as supporting their new technology adoption. Firms with improved profitability are more likely to highlight *Collaboration with other businesses* and *Private, external funding (bank, investor, venture capital)*.

Table 10: The Enablers of Rural SMEs for supporting the Adoption of the New Technology – Firm Profitability

Enablers of Rural SMEs for supporting the Adoption of the New Technology	Number of Businesses		Total
	No improvement in firm profitability	Improved firm profitability	
Public funding	8 (42.1%)	11 (34.4%)	19 (37.3%)
Internal capital (from firm and its owners)	15 (78.9%)	22 (68.8%)	37 (72.5%)
Private, external funding (bank, investor, venture capital)	3 (15.8%)	7 (21.9%)	10 (19.6%)
Market potential	3 (15.8%)	10 (33.3%)	13 (24.5%)
Existing employees with relevant knowledge and skills	3 (15.8%)	6 (18.8%)	9 (17.6%)
Hiring new employees with relevant knowledge and skills	1 (5.3%)	4 (12.5%)	5 (9.8%)
Collaboration with other businesses	3 (15.8%)	8 (25.0%)	11 (21.6%)
Adversary service	1 (5.3%)	3 (9.4%)	4 (7.8%)
Other	2 (10.5%)	2 (6.3%)	4 (7.8%)
Total	19	32	51

Shading denotes statistically significant response using Chi-square test (X^2-test: $p<0.05$).

The Difficulties/Barriers of Rural SMEs during the Adoption/Integration of New Technology

To investigate the difficulties/barriers SMEs encountered during the integration or adoption of new technology, questions were designed as a Likert-Scale where 1 = no difficulties and 5 = most important difficulty. Data are measured on an ordinal scale which are non-parametric, so we apply the Mann-Whitney U (MWU) test to analyse the difference between rural SMEs with and without job generation, with and without improved ability to access new markets, and with and without improved profitability.

The MWU test is a non-parametric test that is commonly used to compare means of two different groups from the same population [3]. It is used when the data do not meet the requirements for a parametric test (i.e. t-test, ANOVA). For example, the data are not normally distributed [4], the

variances for two conditions are noticeably different [5], [4], or the data are measured on an ordinal scale [6]. It is noted that the results of the MWU are presented in group rank differences rather than group mean differences [5].

Comparing the difficulties or barriers experienced by rural SMEs in relation to job generation from technology adoption (Table 11), there are no statistically significant differences between the two groups, implying that rural firms with and without job generation as a result of applying the new technology do not differ in terms of the difficulties/barriers experienced.

Table 11: Difficulties/Barriers of Rural SMEs during the Adoption/Integration of New Technology – Job generation

Difficulties/Barriers	Mean Rank		Mann-Whitney U	P-value
	No job generation	Job generation		
Regulation / limited support by local policy makers	26.56	24.67	250.0	0.662
Funding, lack of financial resources	27.44	22.53	218.0	0.270
Lack of expertise/ skills of existing employees within the firm	27.47	22.47	217.0	0.252
Inability to hire new employees with relevant skills / expertise	25.54	27.10	253.5	0.722
Lack of customer demand or limited interest from stakeholders	26.17	25.60	264.0	0.891
Lack of appropriate external advice / technological skills	25.83	24.64	240.0	0.781
High integration costs	26.15	21.81	192.5	0.333
Difficulties in establishing effective collaboration with supply chain partners	25.50	27.20	252.0	0.691
Competition in the industry	24.53	29.53	217.0	0.246

Note: there is no significant difference for job generation.

Table 12 presents the MWU-test results of the barriers experienced by rural firms with and without improved ability access to new markets as a result of new technology. The MWU-tests find that significant differences exist between rural firms with and without improved ability to access new markets in relation to *Funding, lack of financial resources*, *Lack of customer demand or limited interest from stakeholders*, and *Competition in the industry*. The firms without improved access to new markets are more likely to face the first two barriers. However, the firms with access to new market more highlight *Competition in the industry* as a barrier.

Table 12: Difficulties/Barriers of Rural SMEs during the Adoption/Integration of New Technology – Access to New Market

Difficulties/Barriers	Mean Rank		Mann-Whitney U	P-value
	No access to new market	Access to new market		
Regulation / limited support by local policy makers	27.46	25.74	311.5	0.669
Funding, lack of financial resources	31.35	22.66	222.0	0.035**
Lack of expertise/ skills of existing employees within the firm	27.22	26.83	340.0	0.926
Inability to hire new employees with relevant skills / expertise	27.28	25.88	315.5	0.730
Lack of customer demand or limited interest from stakeholders	30.13	23.62	250.0	0.091*
Lack of appropriate external advice / technological skills	27.71	23.90	258.0	0.328
High integration costs	24.55	26.19	284.5	0.685
Difficulties in establishing effective collaboration with supply chain partners	26.36	25.72	311.0	0.871
Competition in the industry	21.59	29.34	222.0	0.051*

Note: ** and * are statistically significant at 5% and 10% levels

Table 13 indicates the difficulties / barriers experienced by rural SMEs, paying attention to any potential differences between those with and without improved profitability as a result of technology adoption. The MWU test indicates that rural SMEs with improved profitability are statistically and significantly different from the SMEs without improved profitability in terms of *Regulation / limited support by local policy makers*, *Funding, lack of financial resources*, *Lack of customer demand or limited interest from stakeholders*, and *Difficulties in establishing effective collaboration with supply chain partners*. The firms without improved profitability had a mean rank of 32.5 on facing *Regulation / limited support by local policy makers,* while the firms with profitability had a mean rank of 22.1. Likewise, for *Funding, lack of financial resources*, the firms without profitability had a mean rank of 36.3, while the firms with profitability had a mean rank of 19.9. A higher mean rank of the firms without profitability than the firms with profitability face *Lack of customer demand or limited interest from stakeholders with 31.8 and 22.5* respectively. Also*,* the rural firms without profitability are more likely to experience *Difficulties in establishing effective collaboration with supply chain partners* (mean rank = 30.2) than those with profitability from adoption (mean rank = 22.8).

Table 13: Difficulties/Barriers of Rural SMEs during the Adoption/Integration of New Technology – Firm Profitability

Difficulties/Barriers	Mean Rank		Mann-Whitney U	P-value
	No improvement in firm profitability	Improved firm profitability		
Regulation / limited support by local policy makers	32.47	22.16	181.0	0.011***
Funding, lack of financial resources	36.26	19.91	109.0	0.000***
Lack of expertise/ skills of existing employees within the firm	24.42	26.94	274.0	0.543
Inability to hire new employees with relevant skills / expertise	24.61	26.83	277.5	0.592
Lack of customer demand or limited interest from stakeholders	31.84	22.53	193.0	0.017***
Lack of appropriate external advice / technological skills	26.50	24.20	246.5	0.566
High integration costs	25.47	24.75	264.0	0.862
Difficulties in establishing effective collaboration with supply chain partners	30.22	22.84	203.0	0.066*
Competition in the industry	25.50	25.50	288.0	1.000

Note: *** and * are statistically significant at 1% and 10% levels

2.2.3 Section C: Impact and Transferability of the case

Empirical Methodology

In this section, we employ discriminant analysis (DA) to examine the effects of the socio-economic characteristics of rural SME respondents from the eight countries. DA is commonly designed to investigate the difference between two or more observed groups with respect to several underlying variables. It is more appropriate than commonly used measures (i.e. correlations and regressions) when the variables being predicted are categorical [7]. It aims to explain and to predict the observed group on the basis of measurements of explanatory variables. It provides a more rigorous test than one based on univariate comparison of means, and results in a unit of analysis, predicted group membership [8].

The observed groups are here made *a priori* based on the impact of new technology adoption on rural SMEs' competitiveness and productivity which are job generation, ability to access new markets, and firm profitability. These groups are dichotomous variables which are divided into two categories which are 1) job generation and no job generation, 2) access and no access to new markets, and 3) improved firm profitability and no improvement in firm profitability. Also, it is noted that the socio-economic characteristics should be continuous or dummy variables [7]. The model is specified as follow:

$$D_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \varepsilon_i \quad (1)$$

where D = Total score on the discriminant function for i^{th} respondent, i = 1, …, n,

X = Socio-economic characteristics of the respondents (criminating variables) listed in Table 14,

β = Standardised estimated discriminant coefficient for the variable X,

ε = error terms.

Table 14: Definition of the variables used for the discriminant function analysis

Variable	Definition	Description
Dependent		
-Job	Job generation (No. of employees)	Categorical variable: 1 = job generation, 2 = no job generation
-Market	Ability to access new markets	Categorical variable: 1 = access new markets, 2 = not access new markets
-Profit	Firm profitability	Categorical variable: 1 = improved profitability, 2 = no improvement in profitability
Independent		
-TURN	Annual turnover:	Dummy: = 1 if less than 2 million EUR (TURNL)
		= 0 if equal or more than 2 million EUR (TURNH)
-SECT	Industrial sector where the company operate in - Primary sector (SECTP)	Dummy: = 1 if yes and = 0 otherwise
	- Secondary sector (SECTS)	= 1 if yes and = 0 otherwise
	- Tertiary sector (SECTT)	= 1 if yes and = 0 otherwise
-YEAR	The year in which the new technology is adopted the firm	Continuous
-EMP	Total number of employees: - less than 10 employees (EMP10)	Dummy: = 1 if yes, = 0 otherwise
	- 10 – 49 employees (EMP49)	= 1 if yes, = 0 otherwise
	- 50 – 250 employees and over (EMP250)	= 1 if yes, = 0 otherwise
-CTRY	Country where the firm operates in	Continuous
-FUND	Lack of financial resources and funding	Dummy: = 1 if yes, = 0 otherwise
-REG	Lack of regulation or limited support by local policy makers	Dummy: = 1 if yes, = 0 otherwise

2.2.4 Results and Discussion

Descriptive Statistics

Table 15 provides data relating to the mean and standard deviation of socio-economic characteristics of respondents per each observed group. The data shows varied trends in the mean and standard deviation of the variables considered. For job generation, rural SMEs falling under 'job generation' as a result of adoption have a mean turnover of 0.50 million EUR and SD of 0.52 which is higher than a mean turnover of 0.26 million EUR with lower SD of 0.45 for firms with 'no job generation'. This implies

that the rural SMEs experiencing job generation as a result of technology adoption are likely to be generating more turnover.

In terms of industrial sectors, rural SMEs are more likely to generate jobs from technology adoption in primary and tertiary sectors, than in the secondary sector. Additionally, the mean year of adopting new technology by rural SMEs with job generation is 5.79 which is lower than for rural SMEs without job generation (mean of 6.26). This implies that rural SMEs are more likely to generate jobs from adoption, when the adoption is more recent. In the secondary sector, the mean of the number of employees of rural SMEs with job generation is 0.50 which is higher than that of rural SMEs without job generation. More significantly, the rural SMEs without job generation are more likely to highlight problems relating to the lack of funding or regulation / limited support from policy makers with the mean of 0.07 and 0.07 respectively when compared to rural SMEs with job generation (mean of 3.68 and 2.68 respectively).

For improved ability to access to new markets, the mean of rural SMEs' turnover with improved ability (0.45) is higher than that of rural SMEs' without (0.17), indicating that the rural firms with improved market accessibility are more likely to be generating higher turnover after integrating new technologies in their businesses. The number of firms with improved ability to access new markets in both secondary and tertiary sectors is higher than that of firms without improved ability to access to new markets. In addition, the mean number of employees of rural firms with improved ability to access new markets is higher among firms with 10-49 employees and 50-250 employees or over. Moreover, lack of funding and regulation / lack of support from local policy makers are prominent limitations for rural firms without improved ability to access new markets.

Firms with enhanced profitability as a result of adoption tend to generate higher turnover. More firms in the primary sector are profitable than firms in the secondary and tertiary sectors. For year of adopting a new technology, the mean of firms with profitability is lower than that of firms without profitability, implying that firms that have recently implemented new technologies are more likely to have generated profits from their investment. Additionally, firms with less than 10 employees (micro-businesses) are more likely to generate profit from their adoption. Likewise, the mean number of 10 – 49 employees is 0.28 for firms with profitability while for firms without employees is 0.21. More firms in which technology improved profitability identified funding as a barrier as well as regulation /

limited support by local policy makers, than firms without profitability, implying that funding and regulation / local support are more likely to be a key factor to enhance profitability.

Table 15 Descriptive statistics for selected socio-economic characteristics of respondents by observed groups.

Variable	Job generation (N=51)				Access to new market (N=52)				Firm profitability (N=51)			
	Yes		No		Yes		No		Yes		No	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
TURN	0.50	0.519	0.26	0.452	0.45	0.506	0.17	0.388	0.34	0.483	0.26	0.452
SECTP	0.50	0.519	0.37	0.496	0.38	0.494	0.65	0.487	0.59	0.499	0.37	0.496
SECTS	0.14	0.363	0.32	0.478	0.28	0.455	0.22	0.422	0.19	0.397	0.32	0.478
SECTT	0.36	0.497	0.32	0.478	0.34	0.484	0.13	0.344	0.22	0.420	0.32	0.478
YEAR	5.79	4.136	6.26	3.588	5.83	3.596	4.87	3.647	4.72	3.476	6.26	3.588
EMP10	0.36	0.497	0.63	0.496	0.48	0.509	0.74	0.449	0.59	0.499	0.63	0.496
EMP49	0.50	0.519	0.21	0.419	0.31	0.471	0.22	0.422	0.28	0.457	0.21	0.419
EMP250	0.14	0.363	0.16	0.375	0.21	0.412	0.04	0.209	0.13	0.336	0.16	0.375
CTRY	3.50	1.787	3.26	1.759	3.97	1.742	3.00	1.758	3.78	1.791	3.26	1.759
FUND	0.07	0.267	3.68	1.157	2.41	1.211	3.17	1.267	2.22	1.039	3.68	1.157
REG	0.07	0.267	2.68	1.336	1.93	.923	2.35	1.584	1.78	1.128	2.68	1.336
Total	15		36		29		23		32		19	

Source: INNOGROW survey (2017)

Note: SD is a standard deviation.

Results of the Discriminant Analysis

A) The Impacts of Socio-Economic Characteristics of Rural SMEs on Job Generation

Table 16 presents the results of the impacts of socio-economic characteristics of rural SMEs on job generation. After implementing new technologies, 29.5% of firms experienced job generation, while 70.5% of firms did not. Wilk's Lambda is a measure of the overall significance of the linear discriminant function. It tests the significance of each discriminant function and its null hypothesis that the means of all the groups on the discriminant function are equal with respect to job generation. Here, we can reject the null hypothesis ($p < 0.05$) and conclude that the means are different and the function has a discriminatory ability. The Eigen Value is the ratio of the between-groups sum of squares to the within-group sum of squares. The largest Eigen Value corresponds to the eigenvector in the direction of the maximum spread of the group mean [7]. For discriminating only two groups, job generation and no job generation, the Eigen Value gives only one value which is 0.21, and the overall canonical correlations is 0.41 which is acceptable (>0.30) [8][7], implying that it is possible to evaluate the contribution of the socio-economic characteristics in the discriminant analysis. Also, the p-value of Box's M is more than 0.05 ($p>0.05$) [8], implying that the equality of variance-covariance matrix can be assumed. Thus, this function has ability to separate between the groups.

Table 16: Standardised Discriminant Coefficients Function and Structure Matrix Coefficients of Job Generation

Discriminating Variable	Standardised Coefficient Estimates	Structural Matrix Coefficient	F-Ratio
TURN	0.250	0.476	2.228
SECTP	-0.070	-0.055	0.030
SECTS	-0.332	-0.316	.986
SECTT	0.246	0.383	1.447
YEAR	-0.031	0.242	.576
EMP10	0.562	-0.648**	4.134
EMP49	-0.009	0.708**	4.943
EMP250	-0.383	0.011	.001
CTRY	-0.215	-0.047	.022
FUND	-0.250	-0.614*	3.717
REG	-0.070	-0.274	.740
Eigen Value	0.205		
Canonical Correlation	0.413		
Wilk's Lambda	0.830 ($p > 0.05$)		
Equality of Covariance Matrices (Box's Test)	53.270 ($p>0.05$)		
Chi-Square (df=9)	8.119		

Note: ***, ** and * are statistically significant at 1%, 5% and 10% levels

The coefficients of the standardised discriminant function in Table 16 indicate the relative importance of each independent variable in predicting job generation. They also indicate the partial contribution of each variable on the discriminant function in which the coefficients can be used to rank the importance of each variable in the function [8]. The number of less than 10 employees has the highest coefficient of 0.56 which indicates that it has the highest partial contribution to the discriminant function.

Table 16 also reports the Structure Matrix Coefficients which can allow us to explain how closely each variable and the determinant function are related. These coefficients indicate the simple correlations between the variables and the discriminant functions. Also, they provide another way to study the usefulness of each variable in the determinant function [8]. The characteristics that significantly influence job generation from technology adoption within rural SMEs are the number of less than 10 employees, the number of 10-49 employees, and lack of funding sources.

The coefficient of the number of less than 10 employees is found to have a negative correlation with the job generation of rural SMEs resulting from technology adoption. However, the number of 10-49 employees is found to have a positive correlation, implying that a rise in the number of this group contributes to an increase in job generation from technology adoption. In this regard, the results support the notion of De Kik *et al* (2011) [9] that SMEs can be an engine for jo generation. Eurofound (2016) [10] also reveals that firms with 20 employees or more have a positive trend in job creation. Firms with either product or process innovation also tend to create more job [11]. More significantly, lack of funding sources has a negative correlation with job generation, implying that poorer opportunities to seek funding reduces job generation of rural SMEs who are investing in new technology. Muller *et al*. (2015) [12] and Eurofound (2016) [10] concur that one of the main determinants of job generation is investment strategies such as sufficient assets, diversified funding sources and the willingness to invest when needed.

B) The Impacts of Socio-Economic Characteristics of Rural SMEs on Access to New Markets

Table 17 presents the results of the impacts of socio-economic characteristics on ability to access markets. Approximately 56 per cent of rural SMEs have improved potential to access new markets after adopting new technologies, but around 44 per cent do not. The discriminant function of access to new market groups has a discriminatory ability, in which Wilk's Lambda is $p < 0.05$. The Eigen Value provides only one value which is 0.52, and the overall canonical correlations is 0.58 (>0.30), implying

that it is possible to evaluate the contribution of the socio-economic characteristics in the discriminant analysis. Also, the Box's M with p>0.05) implies that the equality of variance-covariance matrix can be assumed. As a consequence, this function has ability to separate between the groups, access to new market and no access to new market.

Table 17: Standardised Discriminant Coefficients Function and Structure Matrix Coefficients of Access to New Market

Discriminating Variable	Standardised Coefficient Estimates	Structural Matrix Coefficient	F-Ratio
TURN	0.021	0.422**	4.608
SECTP	0.549	0.391*	3.964
SECTS	0.058	0.093	0.226
SECTT	-0.361	-0.353*	3.218
YEAR	0.623	-0.186	0.899
EMP10	0.238	0.373**	3.610
EMP49	-0.684	0.145	0.548
EMP250	0.427	-0.340*	2.997
CTRY	0.280	-0.389*	3.909
FUND	-0.021	-0.433**	4.854
REG	0.549	-0.233*	1.409
Eigen Value	0.518		
Canonical Correlation	0.584		
Wilk's Lambda	0.656 (p < 0.05)		
Equality of Covariance Matrices (Box's Test)	73.554 (p >0.05)		
Chi-Square (df=9)	18.980		

Note: ***, ** and * are statistically significant at 1%, 5% and 10% levels

Table 17 also reports the standardised discriminant function coefficients. The number of 10-49 employees has the highest (absolute) coefficient of -0.68, indicating that it has the highest partial contribution to the discriminant function followed by primary sector and limitation of regulation.

The Structure Matrix Coefficients are also presented in Table 17. The characteristics of rural SMEs that are positively and significantly correlated with ability to access to new markets are turnover, primary sector, firms with less than 10 employees, implying that an increase in turnover, the number of firms in primary sector, and the number of employees less than 10 employees contributes to an increase in access to new markets. However, for the tertiary sector, firms with 50-250 employees and more, lack of funding sources, and limitation of regulation / limited support by local policy makers have a negative correlation with improved ability to access markets.

C) The Impacts of Socio-Economic Characteristics of Rural SMEs on Firm Profitability

Table 18 presents the results of the impacts of socio-economic characteristics on profit generation of rural SMEs. Approximately 63 per cent of rural SMEs generate a profit after implementing new technologies, but around 37 per cent do not. The discriminant function of firm profitability groups has a discriminatory ability. The Wilk's Lambda is less than 0.05 ($p < 0.05$). The Eigen Value is 0.93, and the overall canonical correlations is 0.69 which is greater than 0.30, implying that it is possible to evaluate the contribution of the socio-economic characteristics in the discriminant analysis. Also, the p-value of the Box's M is greater than 0.05 ($p > 0.05$).Thus, this function has ability to separate between the groups.

The Standardised Discriminant Coefficients Function is also reported in Table 18 which indicates the partial contribution of each discriminating variable to the discriminant function. They also indicate the relative importance of each variable in predicting firm profitability. The number of 50-250 employees and more has the highest absolute coefficient of -0.86, implying that it has the highest partial contribution to the discriminant function followed by year and the firms with less than 10 employees.

Table 18: Standardised Discriminant Coefficients Function and Structure Matrix Coefficient of Firm Profitability

Discriminating Variable	Standardised Coefficient Estimates	Structural Matrix Coefficient	F-Ratio
TURN	0.437	0.087	0.348
SECTP	0.528	0.238	2.443
SECTS	0.284	-0.153	1.071
SECTT	-0.310	-0.112	0.575
YEAR	0.827	-0.225	2.299
EMP10	0.601	-0.039	0.069
EMP49	0.214	0.082	0.304
EMP250	-0.863	-0.048	0.105
CTRY	-0.440	0.149	1.011
FUND	0.437	-0.692***	21.790
REG	0.528	-0.382*	6.654
Eigen Value	0.930		
Canonical Correlation	0.694		
Wilk's Lambda	0.518 ($p < 0.05$)		
Equality of Covariance Matrices (Box's Test)	45.443 ($p > 0.05$)		
Chi-Square (df=9)	29.251		

Note: ***, ** and * are statistically significant at 1%, 5% and 10% levels

The correlations between the discriminating variables and the discriminant function is also presented in Table 18 as the Structure Matrix Coefficients. They indicate how each variable is related to the function. Only lack of funding resources and limitation of regulation / limited support by local policy makers have a negative correlation with firm profitability. Abdulsaleh and Worthington (2013) [6] argue that the accessibility of funding is important for the ongoing and sustainable growth and profitability of SMEs. Also, a lack of funding (i.e. finance) can constrain cash flow and hamper businesses' survival prospects [13]. The European Commission [14] suggests that personalised help and advice from local business support organisations, in relation to the international trading system, laws and regulations in the foreign country, and so on, can be helpful to expand SMEs' businesses to achieve competitiveness and productivity.

3 Overview of main new technologies for rural economy SMEs

3.1 Innovative production technologies

3.1.1 Organic farming

Definition & innovative aspects

Organic farming has been recognized as one of the most reasonable alternatives to conventional agriculture for overcoming the crisis of climate change. It is defined as a farming system seeking sustainability, enhancement of soil fertility and biological diversity while, avoiding synthetic pesticides, antibiotics, synthetic fertilizers, genetically modified organisms, and growth hormones.

Several organic technologies and machinery [15] enable organic farmers to reduce weed burdens and stimulate crop growth. Tine weeders represent one of the simplest methods of removing unwanted species from both grassland and cropped land, depending on the crop being grown. More advanced methods of organic weed removal have been developed recently to allow working not only in vegetable row crops but also in narrow row and multi-line rows in beds, with the aid of a series of video cameras to identify weeds that are out of place. Further development of organic farming machinery uses the same video image analysis techniques to locate individual plants in order to mechanically remove weeds from between the rows and within them too, using a cam arm which moves in between plants when it identifies weeds present.

Current situation / nature of the market / industry

Organic farming is currently practiced in 162 countries around the world on 37,2 million hectares of farmland [16]. Markets for organic foods have been increasing since the relevant European Union Regulation was enacted in 1991. Worldwide sales of organic food and drinks reached $63 billion from 2008 to 2011 [17].

Organic farmers diversify their businesses by growing several crops simultaneously, often having both livestock and field crops, as diversification reduces economic risk. The organic industry is expanding so rapidly that many organic farmers are relatively inexperienced with organic methods. Many experienced organic farmers have crop yields as high as, or higher than, the average conventional yields. However, the average organic crop yields are often lower than the average conventional yields. The most challenging time is the transition period as farmers switch from conventional to organic agriculture. During this period, the price premium is absent and yields are low to counterbalance the initial investment (ranging from 1500€ to 3000€). During the early stages of conversion, some farmers have reported drops in yields of up

to 30% [16]. Later, yields tend to increase with the number of years under organic management as farmers gain experience and the soil improves.

Impact / Benefits for the SME

Rural SMEs benefit from the adoption of organic farming technologies and machinery due to [18]:

- ✓ Lower input use and costs, as pesticides and fertilizers are avoided.
- ✓ Higher resistance in disease, pest and drought, which results in improved productivity.
- ✓ Higher prices and revenues as rural SME access the market of premium consumers, who recognize organic food as of greater value and are willing to pay premium prices for it.
- ✓ Increased exports to reach a larger number of premium consumers in other EU countries, who make informed choices on organic products and their origin.

As regards environmental benefits and impact, SMEs that employ organic farming techniques and machinery achieve [18]:

- ✓ Better energy efficiency compared to conventional farming: Superior performances in energy efficiency for organic farming are associated with field crops, livestock, and mixed crop farms compared to vegetable and fruit farms.
- ✓ Less greenhouse gas emissions, which is found to be higher for mono-cropping than for multi-cropping, especially in field crops, dairy, and mixed crop farms, compared to livestock, vegetable and fruit farms.
- ✓ Less soil erosion, water conservation, and improved soil organic matter and biodiversity compared to conventional systems, which holds true irrespectively of the crops, regions, and technologies employed.

Inhibitors for adoption

Many rural economy SMEs are hesitant in adopting organic farming techniques due to the following reasons [18]:

- ✓ Weed control is frequently a problem in organic crops because the farmer is limited to mechanical and biological weed control, whereas under conventional production mechanical, biological, and chemical weed control options are often employed.
- ✓ Although advanced tractors enable cultivation even in hard weather conditions, many farmers believe that mechanical weed control is usually less effective than chemical weed control under wet conditions -while the reverse holds true under dry conditions - which can be an inhibitor for adopting organic farming techniques.
- ✓ Limited financial resources to cover organic farmers' needs during the transition period from conventional to organic farming is an important obstacle for integrating innovative organic farming solutions.

- ✓ Organic farming is less economically viable without premium prices. Therefore, organic farmers have to ensure access to a market of premium consumers or other countries beforehand. The premiums for organic food are very variable.
- ✓ Labor inputs are higher in organic farming systems (ranging from 7% to 75% higher), and although they are more evenly distributed over the year in organic farming than in conventional production systems, they can be an inhibitor for adopting organic farming techniques.

3.1.2 Renewable energy

Definition & innovative aspects

Renewable energy technologies allow the production of energy from resources, which are naturally replenished, such as sunlight, wind, rain, tides, waves, and geothermal heat. Renewable energy technologies include, among other, solar photovoltaic systems, sea water air conditioning, solar air conditioning, and solar water heating [19]. Innovations in the field are continuously taking place during recent years, like the invention of new solar thermal storage solutions including molten salt technology that can be integrated in concentrating solar power systems to absorb the heat to make steam for immediate electricity generation or store it for later use. Printable organic solar cells, using semiconducting inks printed directly onto flexible stretchable thin plastic or steel, could also revolutionise photovoltaic solar power generation, reducing the cost of solar cells and performing better in low light conditions [20].

Current situation / nature of the market / industry

The rural tourism sector faces difficulty competing with the majority of non-rural destinations, due to the high cost of fossil fuel imports in remote areas. This difficulty appears not only in the tourism industry but also in greenhouses and stables in rural areas. In response to this challenge, SMEs in rural areas are increasingly investing in renewable energy technologies, such as solar photovoltaic systems, sea water air conditioning, solar air conditioning, and solar water heating, which reduce the cost of energy and guarantee stable generation costs [19]. The costs for installing such systems can vary greatly depending on the insulating materials and methods, the construction materials, the thermal conductivity, the corrosion resistance of the exposed parts, the life span of the entire system under different climatic conditions and the amount of solar radiant energy reaching the surface on which the technology is installed.

The average capital investment cost for solar water heating systems with plant size of 2.1-4.2 kW varies between €1100/kW and €2200/kW. The cost of solar air conditioning systems depends on the level of sophistication of the technology; the average cost is estimated at € 8000/kW. The average investment required for the purchase of grid connected solar photovoltaic systems is € 3750/kW. The payback period of renewable energy investments in hotels in rural areas range between 1 and 11 years [19].

Although rural economy SMEs operating in tourism sector, greenhouses and stables have started adopting such technologies, there is still much to be done to accelerate the transition to renewable energy and reduce dependency on fossil fuel. Policy makers can play a significant role in developing the enabling conditions towards technology deployment in the tourism industry, supporting capital investment, providing incentives for investing in renewable energy solutions, enforcing environmental protection targets mandated by law, and building institutional and technical capacity building.

Impact / Benefits for the SME

Rural economy SMEs can benefit from the integration of renewable energy solutions as [20] [21]:

- ✓ Renewable energy technologies generate considerable cost savings, derived from reduced energy costs.
- ✓ In contrast to diesel-based electricity which is characterised by volatile prices, renewable energy technologies have stable operating costs, assisting rural economy SMEs with long-term business planning.
- ✓ Increased revenues for sustainable hotel businesses derive from eco-friendly travellers, who are willing to pay premium prices for sustainable tourism experiences.
- ✓ The use of renewable energy and/or locally developed energy-saving technologies usually help accommodation businesses to increase tourist numbers, who regard rural areas more luxurious than before. This way rural economy SMEs of the tourism sector can improve their competitiveness.
- ✓ Adoption of renewable energy technologies help rural economy SMEs to reduce their environmental impact, and comply with relevant EU and national regulatory mandates.

Inhibitors for adoption

The key barriers that limit renewable energy technologies deployment in the rural tourism sector are the following [20] [21]:

- ✓ Unfavourable perception of competitiveness of renewable energy options compared to diesel power generation, due to the limited range of use and a potentially challenging integration with the existing electricity grid.
- ✓ Limited access of rural economy SMEs to capital and cost of financing, as an upfront capital cost is required for investing in renewable energy technologies.
- ✓ Barriers related to the ownership status and the different interests of the managing company and the owners of many hotels, who are usually separate entities. Specifically, there is difficulty in motivating the owners to invest in the development of renewable energy solutions, as the energy bill is paid by the managing company, who would be the one benefitting from the energy costs savings. On the other hand, the managing company might consider more convenient to pay for a service instead of investing in infrastructure, which carries an upfront capital cost.

- ✓ Lack of technical capabilities necessary to install and manage renewable energy technologies in tourism facilities. Therefore, the installations performed by unskilled personnel may lead to under-performance and failure of technologies, leading to misperception of the real benefits by hotel owners.
- ✓ Inadequate capacity building programs, creating a gap between demand and supply of the skills needed.
- ✓ Lack of incentives and clear policy instruments, such as introduction of feed-in tariffs or tax rebates, and preferential loan terms for the purchase of renewable energy technologies, to increase technology competitiveness and lower upfront investment costs.
- ✓ Lack of dedicated institutional bodies such as coordinating agencies for renewable energy deployment, and international and regional cooperation mechanisms to overcome technical and institutional capacity barriers.

3.1.3 Precision agriculture

Definition & innovative aspects

Precision agriculture is a farming management system based on observing, measuring and responding to variability in crops, aiming to optimize returns on inputs, while preserving resources. Respectively, precision livestock is the use of advanced monitoring technologies to optimize the contribution of each animal. Both techniques entail interpretation of the measurements to identify when critical limits are reached, and employ automatic control systems to take corrective measures. Innovative commercial precision farming techniques include the use of smart-meters (to measure temperature, humidity, atmospheric pressure, soil temperature, soil moisture, leaf wetness etc.), robotics in dairying, measurement of water usage, egg counting, bird weighing, better control of environment in poultry houses, computerised feed systems, climate control, automated disease detection and growth measurement [22].

Current situation / nature of the market / industry

Precision farming can be considered as “technology push” innovation. Although precision farming technology is available for almost 20 years, and technologies developments were predominately initiated in Europe, Australia and North America, it is still in the early adoption stage [22]. Recent developments in communication technology through mobile phone technology and the internet offer a huge potential benefit to the design, application and value of precision farming. Currently, prices of the most common commercial offerings for precision agriculture and livestock range between 200€ to 40,000€, depending on the technology used (e.g. sensors, drones, guidance systems etc) [23, 24]. In general, there is an inadequate engagement of commercial companies in the precision farming technology development process, which is made mainly by academic organisations.

However, in the next 5-10 years, it is expected that the majority of farmers will deploy sensors around animals that will allow them to effectively monitor a range of useful parameters, such as individual

feeding, heat detection, health monitoring and animal localisation. Mobile robots are emerging for milking, and virtual fencing will contribute to better herd and meadow management and improve financial returns for grazing enterprises [22].

Impact / Benefits for the SME

Introducing precision technology, SMEs can directly observe some of the benefits, such as material savings and improvements in cost-effectiveness. There are also less noticeable, indirect effects, such as reduction of environmental burden and improvements in food safety [25]. The following impacts of precision farming have been documented from previous studies:

- ✓ The savings in pesticide use following the adoption of precision agriculture can be 30,000 tonnes (of pesticide) per annum at EU level, reducing at the same time environmental footprint of farming.
- ✓ The uncertainty of crop yield can be reduced and the reliability of the farmer's income can be increased, using the appropriate combination of technological elements in crop production.
- ✓ The improved management of fertilizer usage and other inputs can boost SME's competitiveness.
- ✓ The employed better matching farming practices with the aid of precision technology result in better quality of crops and livestock products.
- ✓ The improved or objectively documented animal welfare on farms lead to improved product segmentation and better marketing of livestock products.

Inhibitors for adoption

There are a number of obstacles and reasons why the integration of precision farming has not progressed as expected. These are:

- ✓ Limited availability of affordable automated identification systems and/or absence of a good financial background of many rural SMEs.
- ✓ Limited high-speed and affordable internet access in rural areas, hindering effective data storage and analysis or use of more expensive satellite systems.
- ✓ Privacy concerns related to data captured on-farm.
- ✓ Lack of a consistent consulting service for farmers, to maintain technology components, interpret data captured by sensors, formulate and send simple and relevant advice to farmers on a regular basis, and involve users in technology developments so that new technologies better respond to farmers' needs.
- ✓ Absence of clear cost-benefit data and returns of precision farming, and limited awareness about the economical, welfare and environmental benefits of these technologies.
- ✓ Compatibility issues that do not allow widespread use of the technology in the industry, due to the different levels of knowledge and skills of farmers, different farm sizes and financial opportunities.

3.1.4 Crop resistance systems

Definition & innovative aspects

Innovative crop protection mechanisms, such as integrated pest management systems and biological pest control techniques minimize the use of conventional pesticides and consequently environmental impact [26]. Particularly, integrated pest management (IPM) systems are innovative systems of pest prevention, pest monitoring, and intervention, using a range of pest management tools that help rural SMEs minimise crop losses due to pests and diseases [27]. IPM uses non-chemical methods where possible to minimise effects on the ecosystem.

Current situation / nature of the market / industry

Developing IPM strategies and decision making processes related to pesticide treatments require a good knowledge of pest population dynamics in the specific territory. It is also important to have access to effective early warning systems based on the forecasting damages by pests. Such information is necessary to evaluate the economic feasibility of a given IPM intervention. Currently, experience with IPM strategies in Europe is too limited to provide general guidance to rural economy SMEs on the most technically and economically efficient strategies. Actually in Europe, products grown using IPM are rarely identified as such in the market place, and therefore end-consumers does not have clear understanding or knowledge of the technology, and are not willing to pay premium prices for IPM grown products [27]. Nevertheless, in stricter environmental markets, retailers require that suppliers (rural SMEs) apply the general IPM principles to enter the market. Most importantly, since 2014, adoption of IPM general principles has become a legal requirement for such markets. The new legislation, however, is not expected to have major impact on the market, since it just transforms a requirement imposed by retailers into one imposed by the European legislation. To promote adoption of IPM systems by rural economy SMEs, the EU Member States governments should take measures to promote recognition of IPM across the whole agri-food sector, including retailers and end-consumers.

Impact and Benefits for the SME

Adoption of IPM systems offers the following benefits for rural economy SMEs [28]:

- ✓ Pest related benefits, i.e. reduced number of pests and of pesticide applications needed, and reduced occurrence of pest resistance, leading to better crop quality and yield.
- ✓ Economic benefits, i.e. cost savings associated with using less pesticides and improving production. IPM may be more labor intensive than conventional pest control and may require more up front resources. However, costs are generally lower over time because the underlying cause of the pest problem has been addressed.

- ✓ Environmental benefits, i.e. improved environmental safety and impact, helping rural economy SMEs to comply with European legislation.
- ✓ Market benefits derived from the access of early adopters of IPM systems to specific markets segments characterized by strict environmental requirements.
- ✓ Health benefits, especially related to reduced incidents of allergies and asthma, due to the decreased use of conventional pesticides and number of pesticides' applications.

On the other hand, adoption of IPM systems doesn't come only with benefits [27]:

- ✓ An increase of labour costs has been reported due to superficial tillage and crop monitoring.
- ✓ IPM systems usually use bio-pesticide products, which typically achieve slower pest overall kill rates than conventional chemical pesticides, are more sensitive to environmental degradation, and often have a requirement for direct pest contact that necessitates high spray volumes and more informed application procedures.

Inhibitors for adoption

The following factors play a significant role in the adoption of IPM systems by rural economy SMEs [27] [28]:

- ✓ Experience with IPM is still not sufficient in some of the EU Member States to provide guidance on the best IPM strategies, and thus many SMEs perceive high risks associated with IPM, hindering adoption.
- ✓ Products grown using IPM principles is rarely labelled as such, and thus consumers have limited understanding of the approach and less willingness to pay premium prices.
- ✓ Lack of training and advisory services regarding IPM systems intensify the skeptical attitude of rural economy SMEs towards change and innovation, due to gaps in knowledge and experience with the approach.

3.1.5 Novel crop

Definition & innovative aspects

Novel crops are a range of unusual crops such as oil crops, fibre crops and biomass crops, that can be grown for specific end markets, such as fibre production, dietary supplements, plastics, pharmaceutical and energy industries. These are crops which can generate heat and electricity, or produce transport biofuels, used to make a wide range of products [29].

Current situation / nature of the market / industry

Some non-food crop uses such as textiles are widely known amongst the actors concerned, although others may be less familiar such as plastics made from starch-based polymers. The long-term vision of novel crops is that a significant proportion of demand for energy and raw materials should be met through the commercial exploitation of science from crops, in a way that stimulates innovation and the rural economy, enhances biodiversity, reduces greenhouse gas emissions and waste, and slows depletion of natural resources. To realise these gains, science, agriculture and industry need to build collaboration bridges, to disseminate knowledge and encourage changes both in industrial practice and in society [30]. Innovative non-food uses of crops, and their by-products, which may previously have been regarded as waste, can contribute strongly to farm diversification, sustainability of jobs in the industry and new employment opportunities through access to new markets and new sources of income. Many of non-food crops uses are driven by environmental concerns and government sustainability targets, as is the case of biomass crops market, which is expected to grow significantly in the next years due to legislation and governments targets related to the uptake of renewable energy.

Impact / Benefits for the SME

Rural economy SMEs can benefit from cultivating novel crops as [30] [31]:

- ✓ Novel crops can generate new business opportunities in rural areas, providing additional diversity and innovation beyond agriculture. For example, growing energy crops to produce biomass or biofuel gives farmers the opportunity to diversify, and access many different industries and markets as a supplier.
- ✓ Although gross margins depend on the end price for the crop, which can be unstable, it is usually higher than conventional alternatives. Specifically, gross margins for the novel crops in the UK range from around £100/ha to over £600/ha.
- ✓ Production of innovative, higher value added products, which meet more consumer needs, can improve SMEs' competitiveness, while reducing energy use, pollution and waste.
- ✓ The whole industry's economic competitiveness can be improved due to the access to new markets and production of new products by SMEs specializing in novel crops.

Inhibitors for adoption

The following are the main reasons why rural economy SMEs avoid adoption of novel crops [30]:

- ✓ Some of novel crops markets, such as speciality and pharmaceutical crops, are high value - low volume markets. Supplying in these markets requires production to precise specifications, which can be high risk.
- ✓ As the pharmaceutical and cosmetics markets can be sensitive, global supplies are regulated to prevent over-supply and market saturation. This means that there's limited potential for production for the global market.

- ✓ Lack of knowledge and evidence on the impact of novel crops on businesses' competitiveness and productivity due to the limited research on the field, and the inadequate collaboration between industry and science.

3.1.6 Functional foods

Definition & innovative aspects

Functional foods are food given an additional function, usually related to health-promotion or disease prevention, by adding new ingredients or more of existing ingredients. Functional foods include essential nutrients (also called nutraceuticals) are derived from natural foods and can be added to other foods to impact specific health benefits. Some examples include probiotics (microorganisms that provide digestive benefits), omega-3 (fish oil) extracts, and phytonutrients found in plants, such as soy beans, blueberries or grapes. Companies in the sector are currently researching the inclusion of probiotics in beverages and baked goods, fibers in beverages and dairy products, and healthy oils in dairy products [32].

Current situation / nature of the market / industry

There are at least 168 EU companies active in the field of functional foods, and the market within the EU is estimated at approximately 8 billion Euros [33]. Advances in food and medical science as well as changing consumer demand and demographics are drivers for growth in this market. The industry is well positioned to respond to emerging healthcare trends, including personalized medicine and greater incentives to reduce medical costs. Many large multinationals, often in collaboration with specialized ingredient makers, are already established in the market, although SMEs are successfully creating and defending niches in the market. From a sales perspective, soft drinks and dairy products focusing on the energy health benefit are the leading functional food product categories. Soft drinks and dairy products constitute 60 percent of the market among foods, and dairy is gaining in popularity, driven in large part by innovations in yogurts [32]. The industry needs to further educate potential customers to understand and appreciate functional foods' relevance to the health benefit they are interested in, associated with the premium pricing. The various health benefits associated with food is likely to favour further segmentation of products, leading to greater varieties of functional foods in the near future. SMEs entering the market should also consider the leading pharmaceutical therapy areas, and take insights into the patient populations that are expected to grow and seek the related health benefits to functional foods.

Impact / Benefits for the SME

Although cost effectiveness of functional foods in reducing disease burden and lost productivity is currently an important research gap, the popularity of functional foods is increasing and the effect on the food industry is evident. Nevertheless, rural economy SMEs producing functional foods can benefit from this fasting growing and innovative industry, enhancing their competitiveness due to the following reasons [32] [33]:

- ✓ Health conscious consumers are willing to pay premium prices for functional food. Although these products typically require greater initial R&D and ingredient costs, price premiums may reach 30 percent or higher, depending on the product.
- ✓ Functional foods command an average 25 percent profit margin, which is well beyond the percentages that food companies make on many conventional food products.

Inhibitors for adoption

The most basic barriers rural economy SMEs face in the production of functional foods are the following [32] [33]:

- ✓ High costs related to research, product approval and marketing of functional foods.
- ✓ Entry barriers created by large multinational functional food providers, which usually possess complementary assets such as distribution channels, premium client lists, and brands associated with specific food categories.
- ✓ Consumers that may be more sensitive to the higher prices at which functional foods are typically sold as disposable incomes of European citizens fall.
- ✓ Consumer skepticism about the purpose and benefits of functional foods, which can result in limited sales.
- ✓ Need to continuously observe the new EU regulation on health claims for food and the related approval process that usually raise entry barriers to the European market for new companies, or/ and increase the production costs in order to comply with the EU requirements.

3.2 Technologies supporting products' distribution

3.2.1 E-platforms for products' promotion and exports

Description / definition

Online platforms used as contact points among local producers / SMEs and big importers in other EU countries, supporting the entire range of transaction, i.e. demand and supply quantities, specifications and pricing agreement, closing agreements, monitor transfers and payments. For example, the Greek platform CforCrafts, supports Greek SMEs, which specialise in the production of handicrafts products, to increase their wholesale sales in other EU countries and beyond. Similarly, UKTI's E-Exporting Programme helps UK companies sell their products or services to global consumers and suppliers, and grow their business through online exports.

Current situation / nature of the market / industry

Online platforms for products' promotion is a great opportunity for SMEs, to become international traders, by using online marketplaces to become actors in global supply chains. Online platforms gives SMEs the ability to deliver goods online, avoiding the need to establish a physical presence in the country of export, which requires considerable capital and is often not an option for rural SMEs. However, to fully support SMEs to engage in online international trade, trade policy reforms are required; reforms related to the expansion of Internet access and reduction of costs, limitation of barriers to trade in goods, facilitation of procedures to ensure timely and cost effective delivery of goods across borders [34].

Unlike large established businesses and organizations operating in urban locations, SMEs in rural areas face considerable challenges to exploit the benefits presented by the new technologies, while avoiding increased levels of competition from organizations outside their limited market areas [35]. This is usually the main reason that owners/ managers of rural economy SMEs still avoid adoption of ICT solutions, resulting in low levels of online platforms' integration to the rural economy.

Impact / Benefits for the SME

Rural economy SMEs that adapt to the new digital environment are better able to create new business and trade opportunities. The impact associated with the adoption of online platforms' for products' promotion relates to:

- ✓ Higher internationalisation and market expansion for goods / services: SMEs are able to advertise globally their products/ services, access best practice services, and communicate with customers and suppliers in other countries. This is important for transcending local, often sparsely populated markets with weak purchasing power.
- ✓ Increased revenues: SMEs that use the Internet at high levels have revenue growth of up to 22 % higher than those that do not or use the Internet at low levels [34].
- ✓ Improved competitiveness: The cost of business transaction is lower than in traditional methods due to the nature of the Internet. Costs are lower also because producers can communicate directly with buyers, removing any intermediaries, which can result in improved overall competitiveness. Building an alternative supply chain and reducing reliance on conventional retailers enable SMEs to reduce the cost of marketing their name, and to concentrate more on product development and innovation.
- ✓ Improved administration and financial planning: Documents and information about all transactions are kept up to date and centrally located on the platform, reducing the administrative burden for SMEs and facilitating financial forecast.

Inhibitors for adoption

The most basic barriers rural economy SMEs face in the adoption of online platforms for products' promotion are the following:

- ✓ Limited provision of affordably priced high-speed internet access in rural and peripheral areas. Issues of high speed internet prevent rural economy SMEs from taking the risk to compete online in marketplaces.
- ✓ Lack of policy support and regional financial resources towards the development of a common online platform available to rural economy SMEs operating in the region, to promote local products in other EU countries.
- ✓ The language barrier, which deters many owners/managers of rural economy SMEs from participating in e-commerce to increase exports in other EU countries. The online platforms are usually developed in English, which is also the main language of communication, taking for granted that users in other parts of the world are fluent in English, which is not always the case.
- ✓ Costs of using online platform reduce profitability
- ✓ The lack of payment facilities (such as credit cards) and of a secure payments system, which have prevented the completion of e-commerce transactions between rural SMEs and suppliers in other EU countries.
- ✓ Questions of how legal disputes with suppliers and intermediaries are handled, which laws apply and what dispute settlement mechanisms are available when promoting and selling products / services online to other countries, which increases legal uncertainty and prevent SMEs from integrating online platforms to support products' exports.

3.2.2 Online orders and delivery tools

Description / definition

Online orders and delivery tools are online systems allowing customers to place their orders remotely, track their orders, retain preferences, and receive information about availability of products of their interest.

Current situation / nature of the market / industry

In 2014, 190 million Europeans were shopping online, and this number is growing as internet and mobile technologies advance. Despite the compelling statistics, the majority of rural SMEs have not embraced yet the opportunities that e-commerce offers to boost sales, hesitating to engage with customers online. Owners / managers of rural economy SMEs usually prefer to assign the development of an e-commerce site to a technical / e-commerce expert rather than undertake it in-house [36]. Businesses that use online orders and delivery tools either have a system of e-commerce on their own website, allowing customers to order goods and services and pay directly, or use third party websites that allow customers to order directly from them. Amazon and EBay are the most commonly mentioned third party website supporting e-commerce for SMEs. Larger SMEs usually support e-commerce through their own website. In contrast, smaller SMEs dot not always have the capacity and/or skills to effectively run an e-commerce site internally.

Impact / Benefits for the SME

The most usual benefits and impact reported by SMEs relate to increased sales, access to new customers, saved time on marketing campaigns, and reduced costs [36]. Some SMEs found online orders and delivery tools as the decisive factor to reach overseas markets for the first time. An effective online tool enables businesses to streamline the ordering and delivery process, increasing productivity, and competitiveness and reducing operation costs. The above-mentioned impact occurred from:

- ✓ The wider geographical reach achieved, when adopting ICT solutions for e-commerce.
- ✓ The higher speed in interactions between the participants of e-commerce, gaining a lot of time that SMEs can devote to other activities. This means being able to do more work than anticipated, resulting in higher output and increased productivity.
- ✓ Lower costs of business transaction compared to traditional methods, as producers can communicate directly with buyers, removing any intermediaries.
- ✓ The competitive advantage generated from an effective e-commerce strategy, over other SMEs in the industry that do not offer their products and services online, or/and do not have the operating capabilities and skills to do so.

Inhibitors for adoption

Among the most important obstacles that rural SMEs face when competing with larger firms in electronic markets are [35, 36]:

- ✓ A lack of trust among consumers about a not so well-known company; to overcome these difficulties SMEs usually require an agency's support, which results in increased costs.
- ✓ Security issues for credit-card payments and the absence of a human interface in e-commerce, which can create barriers for many potential customers.
- ✓ Many times the lack of payment facilities such as credit/debit cards has prevented the completion of e-commerce transactions.
- ✓ The limited provision of affordably priced high-speed internet access in peripheral rural areas compared to companies operating in urban areas (as is the case with the online platforms for products' promotion).
- ✓ Inadequacies in a range of entrepreneurial skills, including in-house experience and skills for running an e-commerce site or inadequacies in IT literacy skills, failing to deliver the rich experience consumers expect from e-commerce.

3.2.3 Food traceability as marketing tool

Definition & Innovative aspect

Food traceability systems are systems that provide greater transparency and information to customers, enabling them to trace the route of businesses' products. The use of bar coding for product ID systems is the most common tracking tool. Bar coding, QR coding and imprinting tools use tracking numbers to link the products to specific data related to their production history. New laser etching technology enables permanent, tamper-proof etching of a date and traceability code on products, e.g. individual shell eggs, which can be used to find additional data about their origin and distribution.

Current situation / nature of the market / industry

In the European Union, food traceability has become mandatory since January 2005 [37]. Furthermore, sector-specific legislation applies to certain categories of food products (fruit and vegetables, beef, fish, honey, olive oil), so that consumers can identify their origin. There are also special traceability rules for genetically modified organisms (GMOs), which ensure that the GM content of a product can be traced and require accurate labelling so that consumers can make an informed choice.

In France, Germany, Hungary, Italy, Malta, Slovenia and Spain, consumers have a quite good knowledge of the use of traceability in marketing, linking it to the origin of the product, the ingredients and food control. While in Greece, Lithuania, Norway, Poland and the Netherlands, traceability was a vague and sometimes unknown concept in terms of a marketing tool [38].

Traceability of products is considered a new factor of competitiveness in agribusiness, as it is found to be an important criterion of perception of food product quality and safety for many consumers, who would like to more information on what they are buying/eating, identifying its specific origin so that they choose or avoid products coming from a particular country due to ethical or political reasons. The demand for food products with well-identified origin is higher, as consumers have important concerns over the impacts of GMOs on human health and environment, and are afraid of incidents of food-related hazards. Consumers usually prefer a short supply chain, as they are interested in buying directly from the farmer. In some EU countries, including Greece and Italy, consumers are ready to pay more for a well-traced product if the difference in price is low. However, in other countries like Spain, France and the Netherlands, consumers believe that they should not pay more for food safety, as it should be standard for this industry [38]. Previous studies found that consumers in EU countries have a preference for regional products, as they feel safer if the product is made nearby.

Impact / Benefits for the SME

Rural economy SMEs can benefit from the adoption of traceability systems as marketing tools as:

- ✓ Traceability can be a buying criterion for consumers (due to their increased trust), and willingness to pay more, increasing businesses' sales, revenues and competitiveness in the sector.

- ✓ Consumer demand for traceability is expressed directly at the cash register of SMEs operating mainly in the agricultural, agribusiness and pharmaceutical industries, though consumers' willingness to pay. It is also expressed indirectly through import/export policies and government regulations favouring well-traced products.

However, to exploit the advantages of traceability, rural economy SMEs should not focus on high technological solutions, but take into consideration consumers' expectations towards more simple and reliable systems. More complex systems of food traceability seems to introduce more doubt and question rather than confidence and clarity to customers.

Inhibitors for adoption

SMEs may experience lack of knowledge about innovative marketing techniques, as well as cost disadvantages in the adoption of food traceability systems when compared with medium and large-sized companies. The limitations relate to [39]:

- ✓ Lack of information about traceability systems: Information limitation can be lack of "strategic" traceability information (information on product quality, social and environmental ethics, service level) and/or lack of "operational" information (information on legal requirement, hygienic-sanitary safety).
- ✓ Lack of enough knowledge to implement traceability, and lack of appropriate training of the involved staff, which can result in increased staff costs / man-hours.

In order to overcome capacity and awareness limitations problems, activities related to informational flow and training should be coordinated in the case of small scale food supply chain.

3.3 Technologies supporting products' safety

3.3.1 Smart meters and Internet of Things

Definition & Innovative aspect

Internet of Things (IoT) entails the use of sensors, electronics, software, actuators, and network connectivity to provide insightful data regarding operations of businesses through remote monitoring. The real value and innovation of the Internet of Things is at the analysis and leverage of gathered data in real time [40].

Current situation / nature of the market / industry

The Internet of Things will grow to 26 billion units installed in 2020, representing an almost 30-fold increase compared to 0,9 million units installed in 2009. The IoT products and services will generate

revenues exceeding 300 billion euros in 2020. Extensive use of IoT is expected by rural economy SMEs operating in the sectors of agriculture, transportation, and water distribution. By 2020, components costs will have decreased to the point that connectivity will become a standard feature even for processors costing less than 1 euro. This creates opportunities to offer remote control, monitoring and sensing about almost anything [40]. The increasing demand for real-time analytics will drive the use of cloud-scale computing and integration with non-standard, unstructured data sources, promoting the adoption of smart metering analytics, which is currently an underutilized area [40].

Impact / Benefits for the SME

The advantages of smart meters' use for rural economy SMEs are [41]:

- ✓ Better cost efficiency, i.e. reduced cost of running a business through better utilization of resources, and better information used in the decision process.
- ✓ Improved energy efficiency, products' storage conditions, animal behavior / health monitoring, and soil and crop health. These are the most common reasons that rural economy SMEs adopt IoT.
- ✓ Improved productivity and better quality of products, affecting the success and profitability of the enterprise.
- ✓ Availability of new solutions that make products differentiate from the competitors' one, increasing businesses' competitiveness in the market.
- ✓ Adherence to regulatory mandates of their country / region as regards environmental impact and resource efficiency. Smart meters help rural economy SMEs to meet energy and water efficiency requirements particularly.

Inhibitors for adoption

Smart meters integration in rural economy is hindered due to a variety of factors, ranging from technological barriers to the need for new skills and mentality. Specifically [42]:

- ✓ Innovative and more effective solutions should be given in the way non-experienced users could communicate with smart objects and platforms. At the same time, owners and managers of rural economy SMEs need to acquire new skills and competences (especially computer skills, data analysis / understanding), as well as environmentally-friendly behavior and mentality. Changes to the structure and culture occur slowly, which hinders technology integration.
- ✓ Solving technological barriers with a strong focus on security is considered a main inhibitor in smart meters' adoption.
- ✓ Lack of adequate information and of clarity on the best and most suitable technology based on company's needs, prevents rural economy SMEs from adopting innovative solutions in this field.
- ✓ Retrofitting pre-digital age control systems, which are still serviceable, is considered expensive and a hard decision for owners/ managers of rural economy SMEs to make. Resources allocated on testing new solutions can be a considerable investment for a company.

- ✓ Integration of IoT requires a rich eco-system including sensors, network operators, hardware and software providers, which raises concerns about interoperability and scalability of the solution.

3.3.2 Internal products traceability systems and traceability as a supply chain management tool

Definition & innovative aspect

Systems that allow tracking of any food, feed, food-producing animal or substance that will be used for consumption through all stages of production, processing and distribution. Technologies introduced to food traceability industry include barcodes, microcircuit cards, radio frequency tags and transponders, voice recognition systems, bio-coding, and chemical markers, intelligent packaging (temperature-indicator, freshness-indicator, gas-indicator, biosensors), physicochemical techniques (e.g. analysis of variation of the radioactive isotope content of the product) and biological techniques (e.g. analysis of total bacterial flora using different techniques such DNA chips) [43].

Current situation / nature of the market / industry

Europe is leading in developing and implementing food traceability systems. The EU's General Food Law entered into force in 2002 requires that all food and feed operators must be able to identify where their products have come from and where they are going, rapidly providing this information to the competent authorities [37]. Many food companies implement food traceability systems mainly to fulfil new legislations regarding food safety and compete in the market.

Food traceability systems support: a) backward follow-up of products (tracing), b) forward follow-up of product (tracking), and c) product history information associated with the product movement in the supply chain. Cost of food traceability systems depends on the particular technology used. A Radio Frequency Identification (RFID) reader, for example, costs about 10 times as much as a bar code reader. Prices of commercial software applicable for food traceability systems (e.g. QualTrace, EQM, FoodTrack, Safefood360, FoodLogiQ) range between 2,000€ to 15,000€, depending on the technology, features and range of services offered [44].

In the case of small farmers, an efficient paper-based traceability system (simplest form of traceability) or a simple electronic-based system should be adequate to effectively trace the product. This indicates that there is no need of introducing expensive and complicated traceability systems at farm level, which requires enhanced computer/IT literacy.

Impact / Benefits for the SME

Benefits for food companies and SMEs are categorized as [43]:

- ✓ Improvement in food crisis management: Adopting a food traceability system in the supply chain minimizes the production and distribution of unsafe or poor quality products, and limits the

extent of damage by facilitating product recall activities. The result is reduced food recall costs and better performance of food recall activities, through the identification of the affected products, specifying type of the incident occurred, and when and where in the supply chain it occurred.

- ✓ Increase in customer satisfaction: Customers feel confidence in food available in market because of the availability of adequate information about products' origin.
- ✓ Better quality of products in long run based on analysis of traceability information and laboratory test results.
- ✓ Improved agricultural sustainability: Transparency data on food production and sourcing enables the implementation of sustainability initiatives especially at the farm level. Adopting food traceability systems could reduce food product losses in the supply chain, through effective packaging technologies such as temperature-indicator and freshness-indicator. Based on previous research, food losses during distribution can be reduced to levels less than 1% due to effective packaging.
- ✓ Improved access to markets by complying with required safety standards.

Inhibitors for adoption

An efficient full chain traceability system is capital and resource intensive and require significant initial investment [43]. Specifically, inhibitors for adoption include:

- ✓ Financial resources: Developing and implementing traceability systems is expensive and complicated task that could lead to financial problem. It requires much administration and paper works, especially for companies implementing traceability system for the first time.
- ✓ Standardization / Interoperability: The major problem which is common for traceability techniques such as numerical code, bar code, radio frequency identification (RFID) tags is lack of standardization which creates compatibility problems among different solutions introduced by different actors in a supply chain.
- ✓ Staff capacity/skills: Food traceability systems require skilled staff for its implementation and management. Different actors in the supply chain are interested in different ways in food traceability systems, making full chain traceability more complex. Especially in the case of rural SMEs, employees or entrepreneurs need to be trained to handle food items using food traceability.
- ✓ Lack of awareness: Some partners of the food supply chain consider traceability activities as a costly process and extra burden. Appropriate training and information on the concept and importance of food traceability is essential to overcome this barrier.
- ✓ Privacy of personal and company's data: Societal concerns and uncertainty about ethical and privacy issues related to traceability, e.g. personal data are used for tracking consumers' purchases, are still matters to be solved. Businesses are also skeptical on adopting food traceability systems, considering them vulnerable to intrusion into company's data.

- ✓ Need for clear guidelines and regulations: SMEs are usually not aware of the mandatory traceability data to be reported to competent authorities, especially when the full supply chain crosses borders.
- ✓ Problems instituting effective and independent monitoring and compliance systems.

3.3.3 Selective breeding processes

Definition & innovative aspect

Process by which humans use animal breeding and plant breeding to selectively develop particular traits / characteristics by choosing which typically animal or plant males and females will sexually reproduce and have offspring together. Various methods for selective breeding exist, from high-tech and costly processes such as in-vitro fertilisation or genetic engineering to more simple low-cost techniques that rely on the selection and controlled mating of animals based on observable characteristics [45]. Key breeding traits associated with climate change resilience and adaptation include thermal tolerance, disease resistance, low quality feed, high kid survival rate, good body condition and animal morphology.

Current situation / nature of the market / industry

The most commonly selected traits in selective breeding include growth, processing yield, product quality and disease resistance. Unlike the process of creating genetically modified (GMO) crops, selective breeding allows for the natural evolutionary process to take place, which happens at an accelerated rate due to the manipulation performed [46].

The costs for selective breeding process depend on the species and location. In general, controlled breeding is a low-cost technology. If stones are locally available and can be used to build the mating pens, an average investment would be around 30 euros. In areas with clay soils, adobe bricks may be used at an average cost of 90 euros. In many cases, cattle mesh has been the chosen alternative, with an average investment of 200 euros for each mating pen [46]. The prediction of the breeding value of high genetic merit sires will become more and more efficient as total genome sequencing is coupled with much more sophisticated progeny testing and tracking. Advances in systems biology, and knowledge from analysis of genotype – phenotype relationships will make such selection less empirical. Such genetic/genomic technologies will be applied to a number of issues that currently constrain productivity. They will permit improved selection for new fecundity genes that will increase the numbers of offspring, especially in pigs and sheep [46].

To make this happen, support from governmental institutions is needed. Governmental institutions can provide access of SMEs to relevant information, provide technical support for selective breeding, make available information systems to monitor threats to breeds occurred from climate change, and develop predictive modelling and early warning systems, while cooperating with indigenous communities to

benefit from accumulated knowledge. Favoring policies and financial incentives are needed to support breeding and raising breeds more resilient to climate change, marketing of products derived from these breeds, and infrastructure supporting selective breed production.

Impact / Benefits for the SME

Rural economy SMEs can benefit from adopting selective breeding because [45] [46] [47]:

- ✓ It allows the encouragement of plant and animal characteristics that are more beneficial to farmers in terms of productivity. Selective breeding can produce fitter and stronger animals that provide higher yields of meat, milk or eggs, and the gene can be passed on to their offspring. When the method is used on crops, they will also grow more than the typical crops.
- ✓ Selectively bred plants and animals can have higher resistance to pests and diseases. Therefore, farmers can produce animals and grow crops that are better suited to survive in marginal conditions or poor climates, protecting them from developing diseases or deformities.
- ✓ Selective breeding can give plants the ability to grow on lands that are previously not suitable for farming. This means that farming businessman can get an enhanced variety of plants to grow and eventually more food and profit.
- ✓ Selective breeding allows for the creation of high-quality products, increasing the market value of the products and the respective profit.
- ✓ Selective breeding entails low input and maintenance costs, and permanence and consistency of effect once the strategy is established.
- ✓ The method can reverse fertility loss through genome-wide selection on multiple traits, without compromising milk production.

Inhibitors for adoption

The main limitations in adopting selective breeding are the following [45] [46] [47]:

- ✓ Selective breeding of certain genes can reduce or remove other genes from the overall pool, a process which is irreversible. This can create new weaknesses for animals, particularly in the case that a new pest or disease emerges. Similarly, selectively reproduced plants may use more water than the plants around them, drying them out. Depending on the traits chosen, selective breeding may not always lead to higher productivity, a risk that rural economy SMEs are not always willing to take.
- ✓ The systematic underinvestment in expertise, science, technology and infrastructure by governments has not helped the technology's maturity. Industry investment in the field is not adequate to cover the costs, and thus, public funding is needed to further develop and diffuse this technology and achieve sustainable gains in the future.
- ✓ There are knowledge gaps about how breeds react to climate changes. The underlying physiological and genetic mechanisms are still not well analysed and understood by scientific

studies. This makes it difficult to predict climate change impacts or develop adaptation strategies for selective breeding production systems or breeds.

- ✓ Rural development institutions and projects haven't fully documented the indigenous knowledge of livestock keepers about animal breeds, and they may have unrecognised advantages and potential, which hinders diffusion of selective breeding.
- ✓ Selectively breeding plants can grow very tall and become difficult to manage in a controlled environment or greenhouse setting.

4 Spotlight cases

The following 14 most relevant cases of new technologies' adoption by rural economy SMEs were selected for a more detailed analysis based on the **criteria** set in the impact analysis methodology of the INNOGROW project (A1.1), i.e:

1. Cases of rural economy SMEs as defined in section 3 of the methodology.
2. Cases of new technologies as defined in section 4 of the methodology.
3. Cases of new technologies associated with economic, socio-economic and environmental impact, as presented in section 5 of the methodology, leading to increased productivity and competitiveness.
4. Recent cases (timeframe of the last five - ten years).

In principal, each case description is divided into the following parts:

- **Situation / objectives:** background information and brief description of the problem addressed
- **Solution:** description of the main characteristics of the new technology adoption case
- **Main impact achieved / benefits:** brief presentation of the case's evaluation outcomes thus far.
- **Transferability:** brief report on the case's transferability potential

The cases are presented in alphabetical order according to country of origin.

4.1 Bulgaria: Atlantic Way Ltd – Zero waste production process

Situation / objectives

The Atlantic Way Ltd operates in the industry of forestry, specialising in the production of wooden pallets, wooden boxes and wood materials. In addition to its long-term experience in the production of the standard products (pallets and box pallets), the company offers custom made units based on clients' specifications. To this end, Atlantic Way Ltd uses its own production mill and drying chamber, handling a wide range of production sizes, and satisfying short notice orders for the regular customers. Working with its own raw materials, the company's production is independent from the current market quantities.

In 2016, the company decided to focus on the minimization of the waste produced throughout the production process aiming to increase its profitability and to respond to the competition in the industry. The overall goal was to optimize use of resources and increase its profitability.

Country: Bulgaria

City: Tvarditsa

Industry: Forestry

No of employees: 10-49

Annual turnover: less than 2 million

Category of technology adopted: innovative production technology

Year of adoption: 2016

Main source: http://atlanticway.eu/www/

Solution

To move towards a greener and more resource-efficient production process, Atlantic Way Ltd integrated a zero waste technology in the production of pellets. The technology allowed for a combined purchase of a backhoe loader and a production line for pellets, which will not only improve resource efficiency, but also allow for a no-waste logging and timber processing. Furthermore, the company's system for planning and manufacturing secures quantities of all standard prefabricated elements available on stock at anytime. As mentioned above, the company oversees a complete production cycle, starting from the harvesting of the raw materials to the final product, which gives the flexibility to offer a wide range of standard and custom products in volumes from hundreds to thousands within short periods of time. The Zero waste technology led to full utilization of resources, and optimal use of electricity as the waste is used for steam production.

Barriers / difficulties encountered

The main barriers encountered were the availability of funding for the restructuring of the production process and the need to upgrade the skills of current employees and/or to employ new. To overcome these difficulties, Atlantic Way, in collaboration with the REDA Stara Zagora (SZREDA), searched for public funding opportunities and found the solution under the Norwegian Financial Mechanism 2009-2014, in

the context of the Programme Area BG 10 - Innovations in Green Industry. The Norwegian programme funded 60% of the project, covering the cost of equipment and training of personnel. REDA Stara Zagora (SZREDA) offered also advisory and project management services associated with the implementation of technological innovation.

Main impact achieved / benefits

The investment in the zero-waste production technology resulted in increased production and in the opening of 6 new job positions. The company's productivity and competitiveness had a strong positive impact after technology's integration, mainly because of the increased number of employees, the improved energy efficiency, the reduced Greenhouse gas emissions, and the elimination of the waste produced. The technology allowed for better product quality, leading to an increased number of customers, increased prices of products and access to new markets with green potential. A minor positive impact was also noticed in the short time of implementation in company's profitability, employees' skills and workers' productivity.

Transferability

The technology has already been adopted by other rural SMEs in the industry. Transferability potential is favored as the achieved benefits and impact outweigh investment costs by far. Technology transferability is facilitated in cases that regional or national legislation requires achievement of specific environmental targets, and where there is availability of external financing to reduce initial investment costs.

4.2 Bulgaria: Alphatar products - Organic farming

Situation / objectives

In light of the new market potential for organic food in Bulgaria, and to satisfy customers' needs, the Alphatar dairy firm designed and implemented a completely closed cycle of production and quality assurance of its final products, without the use of artificial fertilizers, preservatives, enzymes and any artificial additives. The firm's specialisation in organic products, such as milk, yogurt, vegetables and nuts, resulted from the personal interest of its owners in the technology, aiming to achieve a positive environmental impact and resource efficiency in production. To achieve their objectives, internal capital from the firm and its owners was made available. Private and external funding involving investors, venture capital and loans was also required to implement this project.

Country: Bulgaria

City: Malko Tranovo

Industry: Agriculture

No of employees: Less than 10

Annual turnover: less than 2 million

Category of technology adopted: Organic farming

Year of adoption: 2014

Main source: http://alfatar-milk.com/#c

Solution

The dairy products under the "Alphatar" brand name are produced by the dairy firm "Profarm Group Ltd". Raw milk and raw material for their production are produced in the farms of Plamen Ivanov Dimitrov which are located in the area. Although these are separate companies for accounting purposes, they all have the same owner, ensuring quality in the whole process. Specifically, cow farm animals are fed with corn silage, grain and lucerne hay that have been planted and grown at the firm's own land. Organic farming practices are used in all cultivation activities. After milking, the milk is transported to the dairy, where it is processed. The final products are transferred to "Alphatar" stores, using the firm's transportation (four refrigerated vans), ensuring high quality in transport conditions, and building at the same time a stronger brand name. Having a completely closed cycle of production and trade, the Profarm Group Ltd offers their consumers premium products of high quality and transparency regarding their origin. Best prices are also achieved for organic products due to the limited presence of intermediary bodies and businesses in production, distribution, transportation and trade.

Barriers / difficulties encountered

Availability of public funding was the major difficulty encountered by the firm. Although EU supports organic farming with suitable funding programmes, small producers do not find them very effective due

to the bureaucracy, lots of documentation and fees involved in the funding process. Alphatar producers also faced difficulties in finding personnel with appropriate skills and knowledge in organic farming techniques and organic food market. The people involved in this case feel that they have not yet overcome these barriers, stating that organic farming requires time, investment, experience and training to achieve the results foreseen. Political support is the most important factor for making organic farming technologies a preferred technology for small rural firms.

Main impact achieved / benefits

The organic farming techniques and the closed production cycle adopted by the firm resulted in higher quality of the products offered by the Profarm Group Ltd, making available healthy food to the people in the region. The use of herbicides was minimized, and greenhouse gas emissions were significantly reduced. Strong positive impact was also noticed in the waste produced, the energy efficiency, the water quality and the soil erosion during the production process. Productivity was slightly reduced between 2014 and 2016, although the firm's competitiveness was improved due to the stronger brand name and products quality, resulting in higher selling prices.

Transferability

As the organic food market advances, opportunities for rural SMEs in the industry of agriculture and manufacturing of food and beverages increase. Many consumers' preference in environmental friendly and healthy food is prominent during the last years. As the needs addressed by organic farming are common to many rural SMEs in different regions/countries across the EU, transferability potential of this technology is very high, and replicability of impact can be easily achieved.

4.3 Czech Republic: PROMIX - Crop resistance

Situation / objectives

Proxim s.r.o is a purely Czech limited liability company, operating in the industry of chemical products manufacturing. For the last 20 years, Proxim manufactures and distributes chemicals for garden, household and industrial use. The company puts emphasis on reliability, quality and business partnership, which regularly results in the introduction of many new products in the market and innovations in its production and packaging. The constant objective of the company is to improve its market position and customers' perception. Promix aims at advancing its current position in the market to become the most reliable manufacturer and seller of high-quality and affordable chemicals. Towards this goal, in 2012 the company identified the opportunity to access the agriculture market, providing plant protection products that comply with the principles of integrated and organic farming. The idea resulted from the managers' interest in innovative products in crop resistance systems as an attempt to better satisfy their customers' needs, who are increasingly interested and looking for environmentally-friendly plant protection products against pests.

Country: Czech Republic

City: Rybitvi

Industry: Chemical products

No of employees: 10 - 49

Annual turnover: less than 2 million

Category of technology adopted: Crop resistance system

Year of adoption: 2012

Main source: http://www.proxim-pu.cz/en/

Solution

Having identified the above-described market opportunity, Proxim developed the EKOL Auxiliary plant protection product in 2012. EKOL is an adjuvant used to increase the effectiveness of insecticide spray against overwintering pests on fruit plants. EKOL was nationally approved for use in integrated production and organic farming, as an auxiliary agent, water soluble, containing 90% rapeseed oil and ethoxylated fatty acids. The EKOL product is now an approved and registered product to be used not only for fruit plants, but also for ornamental wood and vine to protect them from overwintering pests. Important factors for the success of the product were the availability of internal capital from the firm and its owners, the well-identified need in the market, and the close collaboration with other businesses in the sector.

Barriers / difficulties encountered

The main barrier encountered during the development of the innovative product was the difficulty and time needed to hire employees with the appropriate skills. Being specialized in treatment of water pool

and pond water, existing employees did not have adequate expertise in the agriculture sector, plants protection and crop resistance.

Main impact achieved / benefits

The development of the EKOL product allowed Proxim to access a new market, that of organic agriculture, increasing its competitiveness and the number of customers. Positive impact was also noticed on the firm's productivity, as well as on the products' overall quality.

Transferability

To the knowledge of the interviewee, there is no similar product to EKOL developed by other companies in the chemical products industry. However, there is transferability potential for the development of similar innovative crop resistance products by SMEs of the industry in different regions or countries, to respond to customers' needs for environmental-friendly products in crop resistance.

4.4 Czech Republic: Sunny Farm - e-platforms for services promotion

Situation / objectives

Sunny Farm Ltd operates in the agro-tourism sector since June 1993. The farm is a training centre for horse racing, providing a carousel for horse mobility, an indoor and outdoor riding hall, and paddocks. The farm, which is located in Holicky village in Pardubice region, offers accommodation facilities as well such bedroom suites, a private restaurant, and a children's playground exclusively for accommodated guests. The services provided in tailored to the needs experiences, skills and fitness level of each guest. Sunny Farm's customers are mainly tourists from Czech Republic and foreign countries rather than local people. To remain competitive and have access to as many customers as possible, the company decided to invest in an online platform for services promotion. The aim of this investment was to increase the revenues of the company, to improve its profitability and to better meet customers; needs who were asking for alternative methods of booking, information and payment of the provided services. In addition to the owners' interest in this online service, the company should also meet new legislation requirements regarding the electronic records of sales and thus availability of online payment methods.

Country: Czech Republic

City: Holicky

Industry: Agro-tourism

No of employees: Less than 10

Annual turnover: less than 2 million

Category of technology adopted: e-platform for product promotion

Year of adoption: 2015

Main source: http://www.sunnyfarm.cz/?q=en

Solution

To respond to the above mentioned challenges and the mandatory legal requirements, Sunny Farm integrated an online booking system, using an existing e-platform for promotion of agro-tourism and accommodation SMEs. The system supports online payment via credit cards, allows for comparison between Sunny Farm's reservations and competitors' ones, facilitating the owners to understand their position in the market and market potential/ opportunities. The initial investment was completely covered by the firm's internal capital. The success of the case lays also on the fact that the company implemented intensive marketing campaigns and participated in foreign events promoting their services and emphasising its social responsibility activities. Positive results in number of booking were achieved in a very short period of time.

Barriers / difficulties encountered

One of the main difficulty encountered during the implementation of this project was the establishment of an effective collaboration among all actors of the supply chain, e.g. booking platform operator, and banks. Agro-tourism and accommodation is a very competitive industry, where innovative solutions are quickly adopted by businesses. Thus companies should constantly search for solutions to differentiate. Moderate problem: Inability to hire new employees. Finally, there was a need to hire new employees with digital skills to handle the online booking and payment process, who was initially hard to find in the area. To overcome these difficulties, Sunny Farm closely cooperated with the management team of the selected platform, exchanging experiences with other actors involved in the system. The day-to-day use of the technology and the improvement of internet connection in the area resulted in a successful integration of the new system.

Main impact achieved / benefits

The impact associated with the adoption of the e-platform for services promotion related only to socio-economic benefits rather than environmental impacts. Specifically, since 2015 (year of technology adoption), Sunny Farm has improved its competitiveness and productivity, having access to a larger number of customers and reducing booking and payment processing time. The number of actual customers increased, although there was an increase in selling prices. Overall, the company documents higher profitability in the last two years.

Transferability

The technology demonstrates high transferability potential because it is easy to use, and doesn’t require specific skills that are hard to find in the industry. Additionally, the achieved benefits outweigh investment costs by far, and the implementation risk is low, making the technology a preferable solution for many SMEs in various regions and countries that face similar needs or legal requirements concerning electronic records of sales and availability of online payments.

4.5 Greece: Thesgala – Innovative products' distribution

Situation / objectives

The THESgala association in the Thessaly region was formed with the vision to offer high quality milk and dairy products to consumers at highly competitive prices, and to support regional rural SMEs to access new markets and become more competitive. 100 Cattle producers with 50 cow milk production units in Thessaly and Macedonia regions are members of the THESgala association. The total milk production is 120 tons per day, which corresponds to approximately 10% of domestic production.

To achieve its goals, THESgala needed to find a solution to reduce costs for producers in the region, taking advance of economies of scale and resources. Farmers of the region find it difficult to sell their products outside Thessaly due to the high distribution, transportation and promotion costs required, and the evident short period of life of milk and dairy products.

Country: Greece

City: Karditsa

Industry: Animal husbandry

No of employees: 50-249

Annual turnover: From 10 to 50 million

Category of technology adopted: innovative product distribution

Year of adoption: 2013

Main source: http://www.thesgala.gr/

Solution

In 2013, THESgala implemented an innovative distribution system worldwide by using vending machines to sell milk, allowing consumers to buy fresh milk directly from farms 24/7. The consumer have the opportunity to find whole and light milk and chocolate, fresh and of high quality. Every day, fresh milk from farms in Thessaly and Macedonia arrives directly to the consumer through the Vending Machines Dairy in less than 24 hours after its production. The milk is pasteurized in modern, certified facilities of the THESgala association. This closed cycle of production and distribution is implemented under continuous cooling facilities and process, where the milk does not come into contact with the environment keeping the maximum of its nutritional components. In addition to the fresh milk, consumers can also find white cow cheese, semi-hard cheese, gruyere and yoghurt in the vending machines of ThESgala. All products are 100% natural and from cows' milk produced in Thessaly and Macedonia regions. The success of THESgala depends primarily on the fruitful synergies and collaboration among the association, the producers, the delivery services, and technology and industry experts. Initially the availability of internal capital from the THESgala association was very important to start the project. Nevertheless, the most significant factor for the success of this case was the hiring of new employees and external collaborators with relevant knowledge and skills and the inspiration to make it happen.

Barriers / difficulties encountered

The most important problem in the implementation of the THESgala project was the difficulty to find and hire people with the appropriate skills, including creativity, innovation management, quality check and assurance and networking skills. Challenges related to supply chain cooperation, availability of initial funding, and competition in the industry was also encountered at first. Barriers related to integration costs for technology transfer in other Greek regions, i.e. Athens and Thessaloniki played important role in the time needed to penetrate in these markets. All these barriers were overcome due to the association's consistency in the target, the involvement of experts and external consultants, the productive partnership with major dairies, suppliers and other local cooperatives in the field, as well as the particular attention and investment in products' quality.

Main impact achieved / benefits

Rural SMEs that participate in the THESgala association benefit from economies of scale regarding products' distribution, reducing promotion and distribution costs and increasing their productivity. Through the THESgala vending machines, farmers have the opportunity to access new markets outside their regional boundaries, significantly increasing their competitiveness. As consumers, who use the vending machines, have the chance to reuse a glass bottle instead of buying packaged milk, producers are cutting out packaging, reducing overall production costs. Due to cost reduction, farmers are able to sell in competitive prices, increasing the number of customers.

Transferability

Although there are no other agricultural associations known that offer products through vending machines, the transferability potential of the THESgala vending machines is high due to the low implementation risks, deriving from the fact that the achieved benefits and impact in the region outweigh the investment costs by far. Additionally, rural SMEs share common needs regarding their products, i.e. desire to access to new markets and reduce their products' distribution costs.

4.6 Hungary: Color-Chips Kft - Selective breeding process

Situation / objectives

Color-Chips Kft. was established in 2013 with the aim to implement a specific innovative project, i.e. to produce colorful chips. The company works in close collaboration with the Potato Research Centre of the University of Pannonia (Keszthely, Hungary) to transfer a selective breeding process and technology for colorful chips into the market. The goal is to offer consumers appealing but more healthy products without the use of artificial dyes. Currently, colored chips available in the market have been produced with the use of additives. The overall objective of the project is to minimize environmental impact and improve resource efficiency in the production process, using natural materials. Based on a preliminary joint experimental work, the Centre provided some unique varieties of potato species which are suitable for producing colored chips. The common objective of the University and the company is to develop a production line with an effective price-value ratio, to provide the snack market with a unique and competitive product.

Country: Hungary

City: Sormas

Industry: Agriculture

No of employees: Less than 10

Annual turnover: Less than 2 million

Category of technology adopted: Selective breeding processes

Year of adoption: 2016

Solution

Based on the University's research results and on public funding from the West-Transdanubian Regional Operational Programme 2007-2013, Color-Chips Kft managed to integrate the most suitable processing lines, which don't require any coloring manufacturing technology. The company chose appropriate raw materials, and optimized the processing techniques based on the characteristics of each potato variety. The final product does not contain any additives, artificial flavor enhancers and preservatives. The salt and oil, as well as the low level of water in the chips act as a natural preservatives. The product fully covers the target consumers' needs who are looking for healthy junk foods in the Hungarian snack market. The product's competitive advantage is the involvement of a research team with scientific and professional background verifying the product's viability and innovation. Color-Chips Kft's next step is to extend its collaboration with relevant enterprises abroad to develop an innovative packaging and effective marketing to make their product unique in the market.

Barriers / difficulties encountered

The most important difficulty, which the company owners had to overcome, was the availability of funding and the negotiation with potential public or private investors and funding sources due to the high technology integration costs required. Other barriers relate to national regulation regarding food quality, and documentation needed to start the production of colorful chips. New employees with expertise in selective breeding process need also to be hired, which proved to be a challenging task initially. Finally, the industry of colorful chips has already attracted some competitors who had identified this market opportunity earlier, thus limiting revenues share and market potential in the industry for new businesses.

Main impact achieved / benefits

The main impact achieved through the adoption of the selective breeding technology was the significant improvement of the chips' quality, which increased the company's competitiveness and at the same time contributed to the improvement of consumers' health status due to the absence of additives and preservatives in the final product. The new technology improved the water efficiency and reduced the greenhouse gas emissions in the production process, improving the company' overall environmental impact. Finally, the integration of the new technology resulted in a minor reduction in the number of employees of Color-Chips Kft.

Transferability

Similar food processing technologies have been already adopted by rural SMEs in different regions and EU countries in the industries of agriculture and food aiming to differentiate from their competitors. The fact that the rural SMEs in the sector share common needs makes the technology highly transferable and essential for responding to highly competitive environments. However, varieties of potatoes suitable for the production of colored chips have to be cultivated in the area to minimize production costs.

4.7 Italy: GaiaG – Internet of Things

Situation / objectives

GaiaG provides effective Decision Support System of Systems (DSSoS) able to monitor remotely, in continuous and in near real time more than 50 environmental variables all over the territory of interest selected and set up by users. GaiaG's Decision Support Systems are a source of key information for many environmental fields, including renewable energies, precision agriculture, and environmental security. Aiming to increase its profitability and revenues, and having identified a new market opportunity, the company decided to develop new decision support systems utilizing data collected through satellites.

Country: Italy

City: Cesena

Industry: ITC

No of employees: Less than 10

Annual turnover: From 2 to 10 million

Category of technology adopted: Smart-meters and Internet of Things

Year of adoption: 2016

Main source: https://www.gaiagsat.eu/

Solution

In January 2016, GaiaG launched a new Software as a Service (SaaS), which exploits ESA's and NASA's Earth Observation satellites, enabling users to monitor more than 50 environmental variables all over the Earth, including solar radiation, wind, air, vegetation, land, soil, weather, sea & oceans, ice, cloud and security (fire, inundation, extreme weather events); factors evidently useful for agricultural activities. This system have been developed by combining satellite data with data sources such as ground-based sensors, manned and unmanned aircraft, and by including them in Spatial Data Infrastructure (SDI). The end product is a structured and user-friendly web Decision Support Systems that is a source of key environmental information. Businesses use the Gaiag's Decision Support Systems to improve precision and efficiency of their production and management processes in order to decrease waste of resources and to reduce production costs. To develop this new technology, GaiaG used regional and national funds in addition to internal capital of the firm and its owners, as well as funding from venture capital and innovation investors. Collaboration with other businesses with expertise in the field was evenly important.

Barriers / difficulties encountered

During this ambitious project, the company faced various challenges. Firstly, stakeholders, such as SMEs' owners, farmers and public bodies expressed limited interest in the new technology, having no previous

experience with such devices and decision support systems. Internal capital was not enough to cover the development costs and the owners had to search for additional resources from public and private funds, which detailed the technology integration. Finally, the company faced difficulties in finding new employees with the skills required, and / or to train the existing employees in the new decision support systems.

Main impact achieved / benefits

GaiaG benefited from the development and selling of the new SaaS through its access in new markets, the improvement of its systems accuracy and quality, increasing thus its competitiveness and profitability. Additionally, the companies that adopted the innovative decision support system benefited with improved water efficiency, reduced use of herbicides, greenhouse gas emissions and soil erosion, based on accurate monitoring of environmental indicators. They also improved the quality and time needed for decision-making processes thanks to the GaiaG's Decision Support System, minimizing overall costs.

Transferability

Many rural economy SMEs, especially in the agricultural sector, have integrated the new decision support system using data collected from satellites. Transferability is facilitated due to the low investment and integration costs compared to the expected impact and the significant decrease in production costs.

4.8 Italy: AGEvoluzione – Smart meters and Internet of Things

Situation / objectives

AGEvoluzione is an innovative startup and R&D Center carrying out research, development and consultancy in the field of the Internet of Things (IoT) offering cutting-edge solutions. Besides its own projects, AGEvoluzione acts as an incubator of external ideas which are developed and transferred into the market, thanks to the company's expertise and production facilities. The philosophy of the company is to promote sustainable businesses growth, developing mechanisms to monitor environmental impact and resource efficiency. To better respond to competition and access new markets, AGEvoluzione decided to develop smart meters and IoT mechanisms useful in the agriculture and agri-business industries.

Country: Italy

City: Pavia

Industry: ITC

No of employees: Less than 10

Annual turnover: From 2 to 10 million

Category of technology adopted: Smart-meters and Internet of Things

Year of adoption: 2010

Main source: http://www.agevoluzione.com/about-us/

Solution

Wi-Node is a wireless device for remote acquisition of field signals. It is actually a microprocessor-based IoT device which enables to monitor operation parameters of hydraulic pumps and electro pumps suitable for watering systems in farming activities and manufacture of food and beverages, and to communicate the data detected by the company's control system or the pump manufacturer's or dealer's remote assistance service. The collected information can be made available both in real-time or stored in a long-run database for subsequent processing. Information stored on removable media and data storage devices can be later transferred to a computer, smart phone or tablet and sent to the help desk or used in-house for troubleshooting or operational statistics useful to optimize production processes. Furthermore, alarm thresholds can be set so that users receive real-time e-mail alerts (Ethernet Wi-Fi and GSM connections) or SMS text messages (GSM connection only) when specific thresholds are exceeded and implemented remedial actions.

To develop the Wi-Node system, AGEvoluzione used public funding from the Lombardia Region as well as internal capital, and private, external funding including loans and venture capital. The company had to employee new people with relevant knowledge and skills and to close collaborate with IT and business consultants to receive guidance about its new strategy goals.

Barriers / difficulties encountered

The major problem during the development of the new technology was the limited skills of existing employees in Internet of things, especially for agricultural purposes. Furthermore, stakeholders, supply chain partners, SMEs' owners and farmers expressed limited interest in sustainable and environmentally friendly technologies, hesitating to adopt new solutions without having previous experience in the field. It was also challenging to find adequate funding to cover the technology's integration costs, which made the project initialization difficult.

Main impact achieved / benefits

Although the technology adopted has not brought significant environmental benefits for the firm itself, the company managed to significantly improve the quality of the products offered in terms of innovation and ease of use, increasing its competitiveness and profitability. The existing employees acquired skills related to environmentally friendly technologies, sustainable agriculture, and resource efficient production of food and beverages. Workers' productivity was essentially improved, reducing the company's overall production costs.

Transferability

The WI-NODE technology has been adopted by many rural SMEs in Slovenia as the achieved benefits / impact outweigh the investment costs by far. The companies gain in production costs and in compliance with possible environmental requirements of their region/country. Regulation is a major facilitator for integrating this environmentally friendly technology, as the supply chain partners increasingly demand IoT solutions.

4.9 Latvia: Peppermint House - Traceability as marketing tool

Situation / objectives

Lolita Duge grows 30 different kinds of mints in her farm in Jelgava city, including apple mint, Swiss mint, orange mint, Spanish mint, Thai mint, mint cream and berry, chocolate mint, grapefruit mint, strawberries mint. She also produces two kinds of cookies, two kinds of syrups, honey with peppermint, tonic for skin, different mint tea bags, soaps with peppermint, aroma bags. She sells her products directly through her Peppermint house near the farm and through a small shop in the center of Jelgava, which sells only local products. Lolita Duge also combines products selling with touristic experiences, tours and workshops for the customers and families they are visiting her shop. Customers have the opportunity to apply for a visit in the Peppermint house and farm, to taste the "Peppermint hut" and different teas, to come across more than 10 varieties of mint, and to learn about the process of home-made mint products like peppermint syrup, powder, face tonic etc. Her professional objective for the next years is to promote the Peppermint House services to customers outside the region or even Latvia.

Country: Latvia

City: Jelgava

Industry: Manufacture of food and beverage products

No of employees: Less than 10

Annual turnover: Less than 2 million

Category of technology adopted: food traceability system as marketing tool

Year of adoption: 2013

Main source: http://www.arenduskoda.ee/Data/2015/Dokumendid/Projektid/Kestlik/Avayritus/Peppermint.pdf

Solution

Looking for alternative marketing tools, Lolita's personal interest in the technology of traceability led her to the adoption of a products' traceability tool, which was first used for tea, syrup, and liqueurs products. Using the technology, the customers had the opportunity to find more information about the origin of the products, the Peppermint House of Lolita Duge, and the services provided to tourists and visitors. To integrate the technology and to build a whole experience around mint cultivation, Lolita Duge used her own financial resources and public funding from the LEADER programme in Latvia. Although the idea is still at an early stage, it is very promising as a new agro-tourism activity.

Barriers / difficulties encountered

There were no major difficulties or obstacles for the owner while developing this idea. The new skills required for the adoption of the traceability system was easily found through the aid of external advice and expertise. Integration costs were the main barrier encountered at first.

Main impact achieved / benefits

The main impact of integrating the traceability system was the increase in the number of customers and visitors in the Peppermint House. The company's competitiveness was substantially increased compared to other local companies.

Transferability

Important factors for transferring not only the traceability system used but also the whole idea in other regions or industries, include the owners' interest in new knowledge and possibilities exploiting customers' hobbies and building touristic adventures. The owners or employees should be ready and open to share their experience with visitors to promote tourism in their area. External financing is major facilitator to cover integration costs, and marketing and advertisement costs. The latter should remain low enough, using alternative methods, such as exhibitions, presence in TV shows, social media.

4.10 Latvia: Baltic Dairy Board Ltd. – Ingredients for functional foods

Situation / objectives

Baltic Dairy Board, a family-owned company, was established in 2008. From 2008 to 2015, the company was engaged in logistics of raw milk and purchase and distribution of other dairy products. In 2015, the company opened a new factory of whey / milk protein and products of high added value in Bauska. The factory is one of the largest milk / whey protein producers in Northern Europe, producing around 8,000 tons of protein powder a year. At present, the company produces non-traditional and innovative milk, whey, lactose products, and milk and whey proteins. It is also involved in an industrial project related to Whey Bioconversion into Ethanol and By-product Processing with the aim to integrate a zero-waste process for the production of sweet and sour whey, improving its resource efficiency and environmental impact. To increase its profitability and revenues, Baltic Dairy Board decided to enter new markets and especially the emerging market of functional foods. This specialization derived from the personal interest of the owners in the industry and the increasing demand from the supply chain partners about ingredients suitable for functional foods.

Country: Latvia

City: Bauska

Industry: Manufacture of food and beverage products

No of employees: 10 - 49

Annual turnover: From 2 to 10 million

Category of technology adopted: Functional foods

Year of adoption: 2016

Main source: http://www.bdbproteins.eu/

Solution

To achieve its goal, the Baltic Dairy Board was involved in the research, development and implementation of the production and sale of new milk / whey ingredients with less fat, through the integration of a controlled enzymatic hydrolysis process for obtaining high-quality whey and milk protein hydro lysate. A modern sewage treatment system was built in the company's facilities, which includes a full cycle of production of whey and milk ingredients for dairy products, including a wastewater treatment system. The laboratory staff works with the latest milk analyser FOSS MilkoScanTM FT2 to provide chemical analysis of raw ingredients, intermediate products and end products. The chemical analysis determines the amount of fat, protein, solids and lactose in the contents of the product. The integration of the technology was supported by public funding through an ERDF-funded project, as well as by external funding from banks, investors and venture capital. Private funding was also required to finish the project. Collaboration with technology experts and business consultants in the field was essential to achieve the company's vision, i.e. become an example in the dairy industry.

Barriers / difficulties encountered

Minor obstacles were encountered during the adoption of the new technology. The most important of them was the limited legal clarity regarding functional foods in Latvia and the controversial interest from stakeholders on functional foods. Initial funding was also difficult to find. Improving the skills of the involved employees was challenging, and building effective supply chain collaboration proved to be time consuming.

Main impact achieved / benefits

Entering the industry of functional foods and providing ingredients to major dairies, the Baltic Dairy Board managed to increase its competitiveness and productivity. The overall production costs were decreased and the quality of products was improved due to the new enzymatic hydrolysis process adopted. As a result, the company increased its prices, the number of customers, the number of employees, as well as it improved the skills and productivity of the involved employees. Baltic Dairy Board also experienced an increase in its exports, improving the level of income. Finally, through the production of less fat products and ingredients for dairy products, the company positively contributed to its customers' health status.

Transferability

The technology has already been adopted by other businesses that focus on functional foods production. The technology demonstrates high transferability potential as the market of functional foods advances and there is high demand for innovative ingredients from the supply chain partners. Furthermore, the achieved benefits and impact, i.e. access to new markets, higher prices and increased productivity and competitiveness, outweigh investment costs by far. Nevertheless, availability of external financing is an important enabler for the successful integration of this technology.

4.11 Slovenia: Halal Guda Doner Kebap – Products' traceability in supply chain

Situation / objectives

Halal Guda Doner Kebap is the biggest Slovenian company for the preparation and sale of rotating seasoned meat spits and doner kebabs. It was founded in 2013, with business premises located in Mlaka pri Kranju. The team consists of 24 dedicated employees, who are focused on meeting customer demands. Distributers of meat products mostly appreciate the responsiveness, reliability and flexibility of Halal Guda Doner Kebap. End buyers remain loyal to the company because of the products' high quality. Specifically, its brand has been built on the products' top quality, as the company uses only sustainable and environmentally-friendly made ingredients, avoiding any additives that are harmful or unhealthy to people and animals. In 2014, to better satisfy customers' needs on food quality, and to access new markets in other Slovenian regions and in foreign countries, the company developed and adopted a product traceability process, involving only reliable suppliers.

Country: Slovenia

City: Kranj

Industry: Manufacture of food and beverage products

No of employees: From 10 to 49

Annual turnover: From 2 to 10 million

Category of technology adopted: Internal products' traceability systems and traceability as a supply chain management tool

Year of adoption: 2014

Main source: http://www.halalguda.com/en/

Solution

The traceability process started with the selection and exclusive cooperation with a number of verified suppliers that naturally produce meat. The company follows and rigidly monitors HACCP (Hazard Analysis & Critical Control Point) and HALAL standards, to ensure the compliance of the food products to the rules of the Islam religion, i.e. comply with certain conditions about healthy production systems, product traceability from soil to table, risk assessment, labeling and continuous quality monitoring. Specifically, all ingredients used to make the Halal Guda Doner Kebap products are of European origin and subject to rigid control regarding quality, traceability, health suitability and fulfillment of statutory standards and requirements. The company uses only ingredients coming from suppliers with Halal certification, to make sure that its products are appropriate for the members of the Islam community. Furthermore, as the production of rotating skewers and doner kebabs requires large quantities of water, making clean water one of the most important ingredients for high quality, the company exploits the potable water coming from the mountains surrounding the company's meat processing plant. Success factors include the availability of internal capital from the firm and its owners, and the effective collaboration with businesses in the sector, building a sales network and a number of satisfied customers that considerably prefer healthy and high quality food.

Barriers / difficulties encountered

The staff involved in the case stated that there were no major problems during implementation. Minor difficulties encountered relates to availability of funding as regards the initial investment and integration costs.

Main impact achieved / benefits

Having established a reliable production process at all stages, Halal Guda Doner Kebap significantly increased its products' quality, productivity and consequently competitiveness. The company managed to increase its exports and to access new markets where Islam community is not a minority, increasing the overall number of customers. Using water from the surrounding mountains and regularly monitoring water quality resulted in a water efficient production process and in improved water quality, which is a major part of kebap production. Overall, the employees that were involved in the traceability process improved their skills and productivity.

Transferability

Products traceability systems throughout the supply chain have been adopted by various SMEs in the food and beverage industry. Enabling factors involve the availability of external or internal financing to cover the initial investment. Many businesses are highly interested in ways to control their products' quality, making traceability a very effective tool to achieve this goal. Transferability of this technology is also facilitated when there is high demand from the supply chain partners and end consumers for traceable products.

4.12 Slovenia: LIT Gorjanc - Renewable energy

Situation / objectives

LIT Gorjanc is a small company in Krajn, Slovenia, operating in the power and energy services industry, producing electricity. In 2010, the company decided to strategically focus on electivity produced from renewable energy resources, with the aim to reduce its production costs, access new markets and approach consumers interested in electricity from renewable resources, increase its profitability, as well as to mitigate the company's environmental impact in order to respond to national legal requirements.

Country: Slovenia

City: Kranj

Industry: Energy and resources

No of employees: Less than 10

Annual turnover: Less than 2 million

Category of technology adopted: Renewable energy

Year of adoption: 2010

Solution

To achieve the abovementioned objectives, LIT Gorjanc invested in hydroelectric power plants for the production of electricity. The company partnered with SIAPRO Ltd., a Slovenian innovative manufacturer of small hydro power plants, to test prototype water turbines and hydropower technology on the basis of two registered patents (P.SI 22,684 and P.SI 23,682). LIT Gorjanc undertook the pilot operation and testing of the innovative water turbines and technology, and the renewable energy production trials, financing the whole project via internal capital (except for the machines and technology which were offered by SIAPRO l.l.c).

Barriers / difficulties encountered

The major difficulty for LIT Gorjanc was to adequately respond to the national regulation and fulfill all legal requirements about protection of environment, water quality, water efficiency and biodiversity in the area. Significant amount of the company's internal capital was required to build and start the pilot testing of the small hydropower plants, which was challenging for the company's cash flow. Business partnership with Siapro l.l.c significantly helped to minimize costs and implement this project.

Main impact achieved / benefits

As hydropower is the most developed area of renewable energy sources, especially in the production of electricity, results are expected soon after the pilot testing phase. Impact is related to significant improvement in energy efficiency, reduction of greenhouse gas emissions, reduction of prices to attract more consumers, and improved workers' productivity. Slight decrease in the company's profitability is expected at the first years of implementation until an adequate new customers database be developed.

Although trials of the innovative small hydropower plants are already showing positive effects, further investment in additional small hydropower plants is needed to reach the expected final impact targets.

Transferability

As the new technology is patented, the particular small hydropower plants have not been adopted by other businesses. Nevertheless, the technology shows high transferability potential, especially in countries that legal requirements about environmental impact and energy efficiency are forcing businesses to make a strategic change towards renewable energy.

4.13 UK: Ahiflower - Novel crop

Situation / objectives

In the UK farmland biodiversity is continually declining for the last 40 years. Pollinator-friendly crops can contribute to improved farmland biodiversity in the soil and the sky at a regional level, and to the productivity and revenues of rural SMEs. Constant research is implemented by agricultural R&D institutes aiming at producing innovative weeds that can become commercial and viable crops.

At the same time, farmers in rural areas, such as Lincolnshire in the UK, are interested in investing in novel crops to increase their profitability and revenue, and to respond to the competition in the industry. Taking into account the novelty and the yet non-measurable impact results of new crops, Lincolnshire farmers are looking for novel crops which don't require the acquisition of special equipment or skills, and that can be tested at a small scale first in coexistence with their existing crops. Farmers are more willing to take the risk to invest in novel crops that have health benefits for consumers, as their market potential is higher.

Country: UK

City: Lincolnshire

Industry: Agriculture

No of employees: Less than 10

Annual turnover: less than 2 million

Category of technology adopted: Novel crop

Year of adoption: 2015

Main source: http://ahiflower.com/

Solution

The new plant Ahiflower has been approved in the US and the EU, as an opportunity for a reliable and profitable crop. This novel food is entering the global market of dietary supplements. Ahiflower has been bred from a weed, commonly known as gromwell or wheat thief. It's a member of the borage family and has high levels of omega-3 fatty acids. It is considered an alternative to fish as a source of omega-3s. Ahiflower is added to functional foods, like salad dressing or omega boosts for smoothies, and it is used as a supplement. Ahiflower is also vegan, plant-sourced, sustainable and traceable to the fields in which it is grown, at least in the UK. The market potential and opportunity if big, and farmers can easily invest in this crop variety as it doesn't require any specific equipment or skills.

Barriers / difficulties encountered

The most important barrier for growing Ahiflower crops is that they can be grown only on selected pieces of land in the UK. The company responsible for the research and invention of Ahiflower (Natures Crops International) follows a proprietary process of identity preservation named Crop Assured 365®. This process has been adopted to guarantee the quality of products, ensuring against co-mingling through segregation, isolation and containment of genetic material, and to make Ahiflower products 100%

traceable. Thus consultation, lots of research and information, and collaboration with other businesses in the field are required, before deciding to invest in this novel crop.

Main impact achieved / benefits

Farmers, who invest in Ahiflower crops, report higher on-farm revenues per hectare. They experience a minor positive impact on productivity and competitiveness, higher prices and consiquently improved level of income. Although Ahiflower is not favored as a forage crop by birds, it does attract a diverse set of pollinators, who in turn are favored by birds, bats, and reptiles. Ahiflower requires less land and less water than flax to deliver the healthy omega-3 and omega-6 fatty acids, improving the SME's resource efficiency, and having a positive impact on soil erosion. Being a sustainable crop favoring green farming, Ahiflower can be planted without herbicides' use. Health status of farmers and their families is improved, as Ahiflower products are nutritional supplements and food ingredients that deliver omega 3, 6, 9 fatty acids, which are essential for health, vitality and wellness.

Transferability

The Ahiflower crops have already proven to be highly compatible with UK growers' sowing and harvesting equipment, and have shown good potential to improve revenues per hectare of farm. They are easy to cultivate and they do not require any specific skills, increasing thus transferability potential. This combination of low-input requirements and a long blooming cycle guarantees the low implementation risks for rural SMEs, which usually share common needs and perspective towards new varieties of crops.

4.14 UK: Beck Hill Farm Ltd. - Precision agriculture

Situation / objectives

Since 1974, Beck Hill farm is operating in the agricultural and animal husbandry sector, growing cereals (except rice), leguminous crops and oil seeds, and raising cattle and buffaloes. In 2008, aiming to respond to the increasing competition, to reduce the production costs in order to maximize profitability, the owners started looking for environmentally friendly methods of farming to maximise resource efficiency in production and company's environmental impact.

Country: UK

City: North Yorkshire

Industry: Agriculture

No of employees: Less than 10

Annual turnover: less than 2 million

Category of technology adopted: Precision agriculture

Year of adoption: 2008

Solution

The solution to the achievement of the company's goal was found in the UAV (unmanned aerial vehicle) systems suitable for precise weed management. The adopted UAV operates by remote control and it is used not only to capture imagery, but also to perform soil and crop analysis through multispectral sensors. The UAV is fitted with a pump system, and based on the data analysis; the flight computer controls the pump to apply fertilizer in an accurate way, which is very effective for the agriculture activities of the company.

Barriers / difficulties encountered

The major problem for the integration of UAV in the production process was the lack of technical skills of the existing employees and owners, and the lack of external advice on methods and technologies for precision agriculture. The second most important difficulty encountered was the limited financial resources of the company, which could not easily cover the technology's integration costs. To overcome these obstacles, the owners attempted to establish a close collaboration with the research and industry experts to learn and exploit the full potential of the new technology.

Main impact achieved / benefits

The use of the UAV provided the opportunity for the Beck Hill farm to significantly reduce labour costs, and to improve the company's productivity due to the more effective use of technologies and agricultural methods. The reduction in the use of fertilizers and herbicides resulted in the overall reduction of production costs and in an improvement in soil erosion in the farm. The company benefited also in energy consumption, making its production process more energy efficient. The reduced level of pesticides' use

attracted more consumers, especially people who prefer environmentally friendly products. The company experiences a significant increase in its profitability, especially compared to its competitors in the region.

Transferability

UAV systems have been used by other rural economy SMEs in various regions across EU countries, especially for agricultural purposes, as the achieved benefits and impact outweigh investment costs by far, and the implementation risks are considerably low.

5 Conclusions and policy recommendations

5.1 Matrix of new technologies' impact

The following matrix has been created based on the cases and data analysis of the current study, with the aim to make available to public authorities and policy makers an effective tool for policy optimisation. The matrix presents the three main areas of impact resulted from the new technologies adoption, i.e. job or no job generation, access or no access to new markets, improved or not improved profitability, in relation to the regional conditions, i.e. enablers and barriers encountered by rural SMEs, in an attempt to demonstrate under which conditions new technologies work best.

Matrix of new technologies impact: Impact areas, enablers, barriers

		NEW TECHNOLOGY IMPACT AREAS		
		Job generation	**Access to new market**	**Profitability**
ENABLERS	**Availability of private, external funding**	Positive impact	Not significant impact	Not significant impact
	Existing employees with relevant skills	Not significant impact	Positive impact	Not significant impact
	Collaboration with other businesses	Not significant impact	Not significant impact	Positive impact
BARRIERS	**No political support / regulation**	Negative impact	Negative impact	Negative impact
	Lack of customer demand	Not significant impact	Negative impact	Not significant impact
	Lack of establishment of effective collaboration with supply chain	Not significant impact	Not significant impact	Negative impact
	Lack of funding / resources	Negative impact	Negative impact	Negative impact

Taking into account the impact area that they would like to focus, policy makers have to make sure that incentives to be provided to rural SMEs are related to the enablers presented in each niche, and at the same time to take precautions to minimize the impact of potential barriers to be encountered.

Based on the results of the desk and field research, the data and the spotlight cases analysis, recommendations for policy makers in rural areas are presented below for each impact area.

5.2 Policy recommendations to promote job generation

Policy makers that would like to promote job generation in their areas are advised to provide incentives to SMEs to adopt new technologies, by making available diversified funding sources, minimising at the same time the time needed to receive the funding and avoiding too much bureaucracy. Our study demonstrates that SMEs operating in the primary sector (agriculture, forestry, animal husbandry and aquaculture), and in the tertiary sector (tourism and others), and employee 10-49 employees are more likely to increase the number of job positions as a result of adopting a new technology. Taking into account the above mentioned, policies related to job creation would be more successful if they focus on SMEs of 10-49 employees of the primary and tertiary sectors and provide financial incentives / funding for integrating new technologies.

5.3 Policy recommendations to enable SMEs' access to new markets

When the policy goal is to help rural SMEs to enter new markets to increase their overall turnover, and become more competitive in the industry, policy makers should provide incentives for new technologies adoption especially to the following two categories of SMEs: a) SMEs of less than 10 employees, operating in the agriculture, forestry, animal husbandry and aquaculture industries, and b) SMEs of 50-250 employees, operating in the tourism industry. These categories of rural SMEs have showed greater potential and success on entering new markets due to the integration of a new technology, optimizing thus policies implementation.

5.4 Policy recommendations to help SMEs increase their profitability

In case that rural SMEs face difficulties in remaining competitive due to limited or no profitability, it is recommended that policy makers offer incentives related to funding sources for SMEs to adopt new technologies, as well as incentives to collaborate (vertically or horizontally) with other businesses to achieve economies of scale or to acquire access to knowledge, skills and specialisation that are currently not available inside the firm. To optimise policy implementation towards this goal, it is recommended to focus policy efforts on either firms with less than 10 employees or firms of 50-250 employees, which have showed greater potential on increasing their profitability through the adoption of new technologies, according to the current study.

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7 Annex: Case documentation form

Activity 1.1: Investigating innovative technologies' impact on rural economy SMEs competitiveness and productivity		
Case title:		
A. CASE IDENTITY		
LOCATION	**Organisation:**	
	Country:	
	Region:	
COMPANY PROFILE	**Industry:**	
	Turnover:	
	Number of employees:	
NEW TECHNOLOGY	**Category of technology:**	Innovative production technologies ☐ Technology supporting products' distribution ☐ Technology supporting products' safety ☐
	Type of technology:	☐ Internal products' traceability system and food traceability system as a supply chain management tool ☐ Smart-meters and Internet of Things ☐ Selective breeding and feeding processes ☐ E-platforms for marketing products and services ☐ Online orders and delivery tools

		☐ Food traceability system as a marketing tool ☐ Organic farming, biotechnology ☐ Renewable energy ☐ Novel crop ☐ Precision agriculture ☐ Crop resistance system ☐ Functional foods ☐ Other, please specify…….
YEAR OF ADOPTION	**Date of new technology adoption:**	Year [……]

B. CASE DESCRIPTION

Business profile and industry description:

(e.g. key business activities, human and financial capital, competitiveness in the industry, opportunities for investments, skills of employees etc.)

Description of the new technology case:

C. NEEDS, ENABLERS AND BARRIERS TO TECHNOLOGY ADOPTION	
Main needs & objectives to adopt the new technology	☐ Reduce production costs ☐ Respond to competition ☐ Access new markets / identified market opportunity ☐ Increase profitability, revenue ☐ Satisfy customers' needs ☐ Improve environmental impact / resource efficiency ☐ Personal interest in the new technology ☐ Meet legislative/policy changes ☐ Other (please specify)
Main difficulties /barriers / local conditions hindering technology adoption	☐ Regulation / limited support by local policy makers ☐ Funding, lack of financial resources ☐ Lack of expertise / skills of existing employees within the firm ☐ Inability to hire new employees with relevant skills / expertise ☐ Lack of customer demand or limited interest from stakeholders ☐ Lack of appropriate external advice / technological skills ☐ High integration costs ☐ Difficulties in establishing effective collaboration with supply chain partners ☐ Competition in the industry Other relevant info provided: …….

Main enablers / local conditions / success factors supporting technology adoption	☐ Public funding (if yes, what source_____) ☐ Internal capital (from firm and its owners) ☐ Private, external funding (bank, investor, venture capital) ☐ Market potential ☐ Existing employees with relevant knowledge and skills ☐ Hiring new employees with relevant knowledge and skills ☐ Collaboration with other businesses ☐ Advisory service (if yes, what source_____) ☐ Other (please specify)..... Other relevant info provided: …….
D. IMPACT AND TRANSFERABILITY POTENTIAL	
Identified economic and socio-economic impacts	☐ Productivity of the firm ☐ Competitiveness of the firm ☐ Costs of production ☐ Product or service quality ☐ Ability to access to new markets ☐ Firm exports ☐ Number of customers ☐ Prices of product/ service(s) sold ☐ Firm profitability ☐ Local cost of living ☐ Health status of people in the area ☐ Income levels locally ☐ Skills of those employed in the firm ☐ Productivity of workers

	☐ Number of employees Other relevant info provided: ……
Identified environmental impacts	☐ Energy efficiency ☐ Water efficiency ☐ Amount of waste produced ☐ Use of insecticide and herbicide(s) ☐ Greenhouse gas emissions ☐ Water quality ☐ Level of soil erosion Other relevant info provided: …….
Transferability potential	