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REGIONE AUTÒNOMA DE SARDIGNA
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TRANSDAIRY

Innovation potential and needs in the Dairy value chain –Technical report

PARTNERS: AUA (PP4), ICCS (PP7)

WP3 – OUTPOUT 3.6

SUMMARY

In this deliverable we present the Technical Report about the innovation potential and needs in the Dairy value chain. The results of this report are based on information collected thrugh questionnaires in the Mediterranean region for the demand and offer of new technological solutions. The market needs novel solutions to address the modern challenges in the DVC. Stakeholders are willing to invest in new solutions. On the other hand, there are currently available technological solutions at reasonable prices for the DVC as well as the proper channels to introduce them to the market. Technology transfer and transborder cooperation is required for the wider adoption of novel technological solutions.

INTRODUCTION

In this deliverable we present the outcome of Activity 3.6.1- "Technical Report about the innovation potential and needs in the Dairy value chain", which is a Technical Multi-faceted Report produced by exploiting the scouting and screening activities to identify the innovation potential and needs in the Dairy value chain, their cost and benefits and the maturity of the companies to adopt the innovations. The support and strengthening of each link of the value chain is required to maintain or increase productivity, financial outcomes and sustainable development of the sector. Modern consumer trends and product requirements set a high standard of quality of dairy products, thus making the maintenance of high production levels at a reasonable price, a challenging task. Considering this market status, demand-driven technology transfer and implementation of novel solutions may be the key to achieve these goals. In this context, we conducted a survey to identify the demand and offer of new technological solutions and characterize the innovation potential and needs in the DVC with the ultimate goal to provide the collected information to DVC actors in a structured way.

METHODS

The collection of information about the innovation potential and needs in the Dairy value chain, their cost and benefits and the maturity of the companies to adopt the innovations was performed using structured questionnaires (these have been previously reported). Partners scouted about the demand and offer in their home regions. The scouting of demand for both Nano/Bio and ICT KET solutions was done with an integrated questionnaire, as most actors in the DVC require KET solutions from both categories of KETs. On the contrary, scouting for offer was performed with 2 independent questionnaires as new KET solutions are provided by specialized companies. To successfully engage stakeholders and collect a sufficient number of questionnaires we exploited the living lab activities (e.g. focus groups, entrepreneurship course etc.) and our market contacts. All questionnaires were also available online to facilitate their dissemination, as well as data analysis. Collected data were either analyzed directly from the online platform on which the questionnaires were uploaded or using the statistics program SPSS v.23.

MAIN FINDINGS

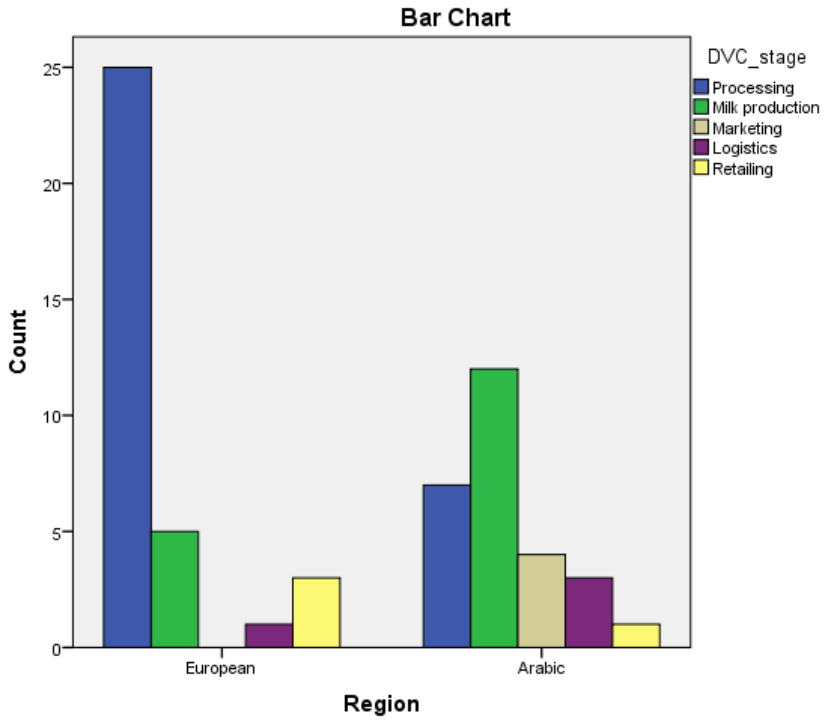
Demand of new KETs solutions

Eighty-eight questionnaires for the demand of new KETs across the Mediterranean were collected, however 69 were available in the online platform and therefore included in this report. The analysis of the questionnaires was conducted on a regional level (European vs Arabic regions) to identify any differences due to the different economic, legislative and cultural basis of the two regions.

On the table and bar chart below there is a detailed description of the distribution of the stakeholders in the various DVC stages across Mediterranean regions.

Region * DVC stage

			DVC_stage					
			Processing	Milk production	Marketing	Logistics	Retailing	Total
Region	European	Count	25	5	0	1	3	34
		% within DVC_stage	78,1%	29,4%	0,0%	25,0%	75,0%	55,7%
	Arabic	Count	7	12	4	3	1	27
		% within DVC_stage	21,9%	70,6%	100,0%	75,0%	25,0%	44,3%
Total		Count	32	17	4	4	4	61
		% within DVC_stage	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

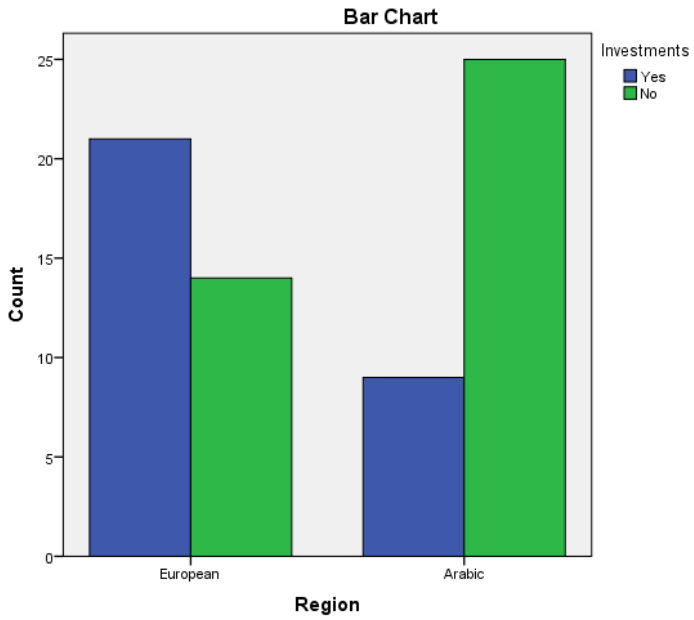


Investments in new machines, solutions, ICT, Nano/Bio, services in the last five years

The participants were asked if they invested in technologies/solutions within the last 5 years. The **majority of participants in European countries** had invested in novel technologies in their line of work, whereas the **opposite was observed in Arabic countries** (see table below). Investments during the last 5 years were **significantly affected by the region** (chi-square test, $p=0.005<\alpha=0.05$, see the respective section of the statistical annex) with a **moderate relationship** (phi value=0.338, $p=0.005<\alpha=0.05$, see the respective section of the statistical annex), with more investments in the DVC being recorded in the European countries.

Region * Investments Crosstabulation

			Investments		Total
			Yes	No	
Region	European	Count	21	14	35
		Expected Count	15,2	19,8	35,0
		% within Investments	70,0%	35,9%	50,7%
	Arabic	Count	9	25	34
		Expected Count	14,8	19,2	34,0
		% within Investments	30,0%	64,1%	49,3%
Total		Count	30	39	69
		Expected Count	30,0	39,0	69,0
		% within Investments	100,0%	100,0%	100,0%

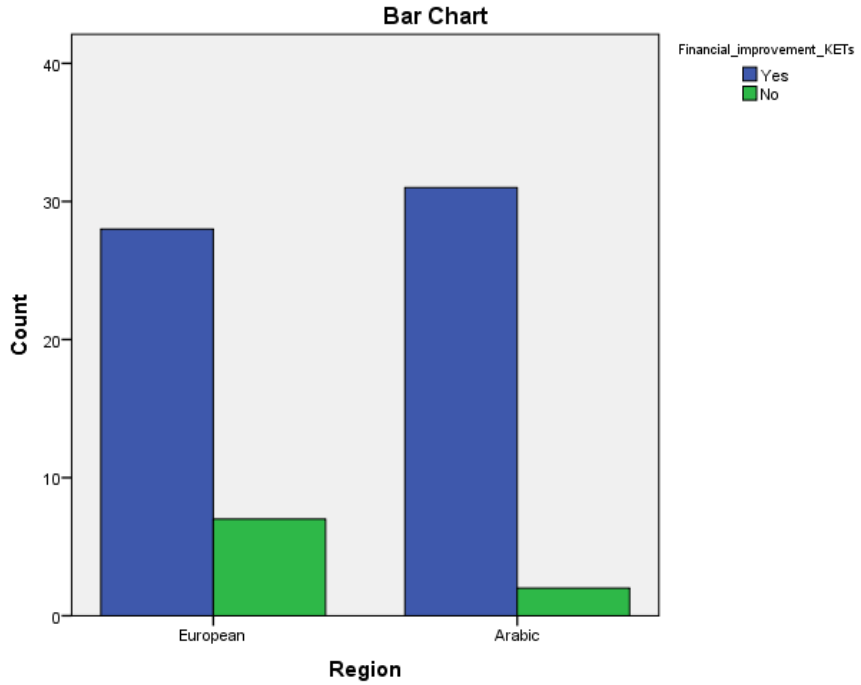

Bar Chart
Investments
Yes
No
Count
25
20
15
10
5
0
European
Arabic
Region

Improvement of financial outcome with the application of novel technologies

The participants were asked if they thought that new technologies/solutions would improve their financial outcome. The majority of participants thought **that novel solutions would improve their monetary gains** (80% in European region and 93.9%in the Arabic region (see table below). However the difference recorded was **not significantly affected by the region** (chi-square test, p=0.09>α=0.05, see the respective section of the statistical annex).

Region * Financial_improvement_KETs Crosstabulation

			Financial_improvement_KETs		
			Yes	No	Total
Region	European	Count	28	7	35
		Expected Count	30,4	4,6	35,0
		% within Region	80,0%	20,0%	100,0%
		% within Financial_improvement_KETs	47,5%	77,8%	51,5%
	Arabic	Count	31	2	33
		Expected Count	28,6	4,4	33,0
		% within Region	93,9%	6,1%	100,0%
		% within Financial_improvement_KETs	52,5%	22,2%	48,5%
Total		Count	59	9	68
		Expected Count	59,0	9,0	68,0
		% within Region	86,8%	13,2%	100,0%
		% within Financial_improvement_KETs	100,0%	100,0%	100,0%



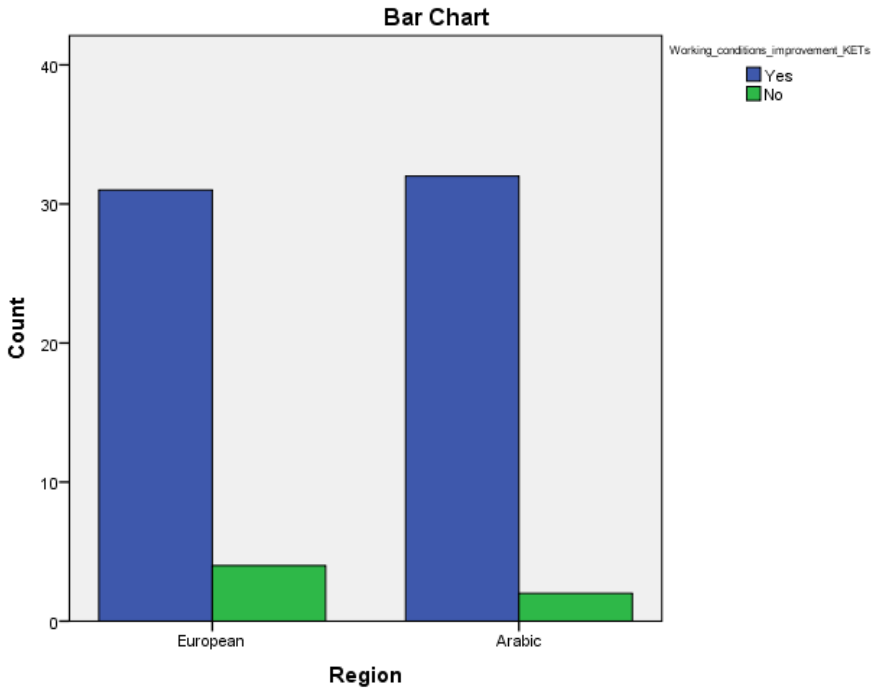
Improvement of working conditions with the application of novel technologies

The participants were asked if they thought that new technologies/solutions would improve their working conditions. The majority of participants thought **that novel solutions would improve their working conditions** (88.6% in European region and 94.1%in the Arabic region (see table below). However the difference recorded was **not significantly affected by the region** (chi-square test, p=0.414>α=0.05, see the respective section of the statistical annex).

Region * Working_conditions_improvement_KETs Crosstabulation

			Working_conditions_improvement_KETs		
			Yes	No	Total
Region	European	Count	31	4	35
		Expected Count	32,0	3,0	35,0
		% within Region	88,6%	11,4%	100,0%
		% within Working_conditions_improvement_KETs	49,2%	66,7%	50,7%
	Arabic	Count	32	2	34
		Expected Count	31,0	3,0	34,0
		% within Region	94,1%	5,9%	100,0%

	% within Working_conditions_improvement_KETs	50,8%	33,3%	49,3%
Total	Count	63	6	69
	Expected Count	63,0	6,0	69,0
	% within Region	91,3%	8,7%	100,0%
	% within Working_conditions_improvement_KETs	100,0%	100,0%	100,0%



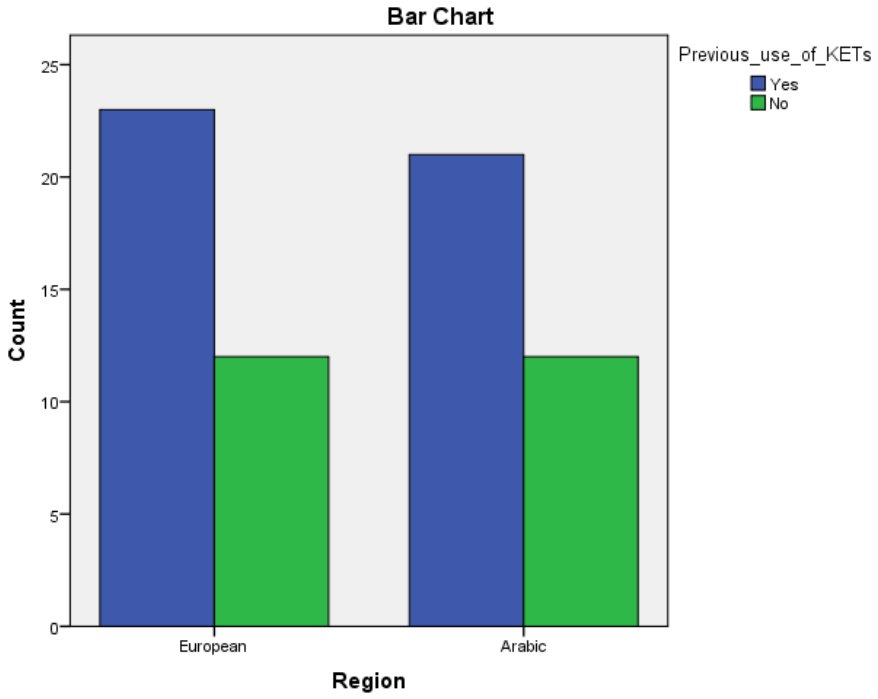
Previous use of novel technologies in the DVC

The participants were asked if they had previously used new technologies/solutions in their line of work. The majority of the participants **had previously used novel solutions** (65.7% in European region and 63.6%in the Arabic region (see table below). However the difference recorded was **not significantly affected by the region** (chi-square test, p=0.858>α=0.05, see the respective section of the statistical annex).

Region * Previous_use_of_KETs Crosstabulation

		Previous_use_of_KETs		
		Yes	No	Total

Region	European	Count	23	12	35
		Expected Count	22,6	12,4	35,0
		% within Region	65,7%	34,3%	100,0%
		% within Previous_use_of_KETs	52,3%	50,0%	51,5%
	Arabic	Count	21	12	33
		Expected Count	21,4	11,6	33,0
		% within Region	63,6%	36,4%	100,0%
		% within Previous_use_of_KETs	47,7%	50,0%	48,5%
Total		Count	44	24	68
		Expected Count	44,0	24,0	68,0
		% within Region	64,7%	35,3%	100,0%
		% within Previous_use_of_KETs	100,0%	100,0%	100,0%



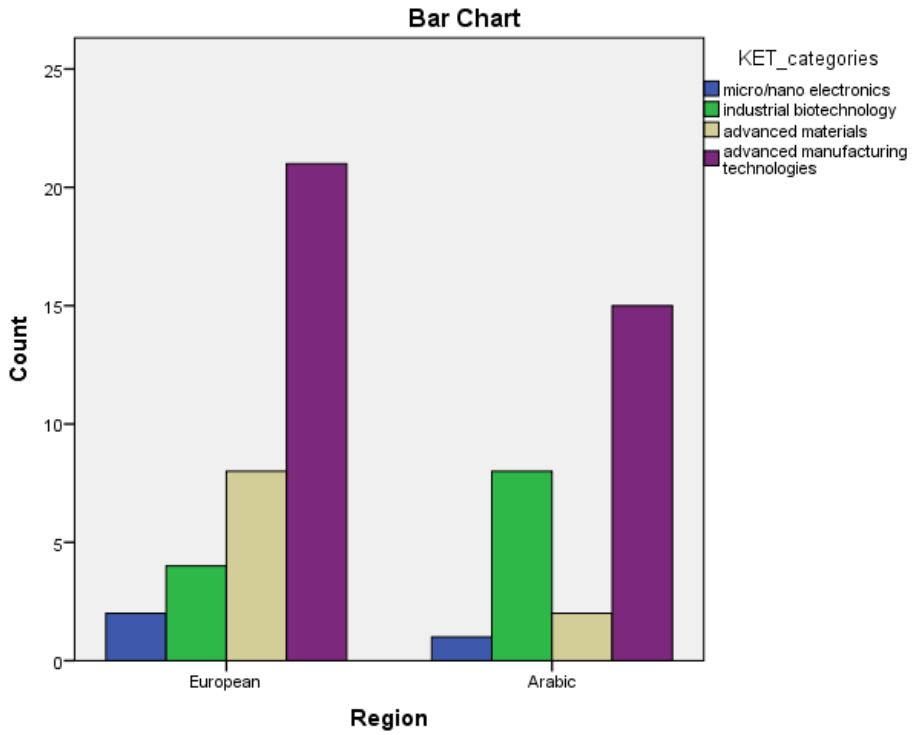
Importance of KET categories

The participants were asked what type of KET technology (micro/nano electronics, nanotechnology, industrial biotechnology, advanced materials, photonics, advanced manufacturing technologies) would be important in their line of work. The majority of the participants **identified advanced manufacturing technologies** (60% in European region and

57.7% in the Arabic region) followed by either **advanced material** (22.9% in European region) or **industrial biotechnology** (30,8% in Arabic Region) (see table below). However the difference recorded was **not significantly affected by the region** (chi-square test, p=0.168>α=0.05, see the respective section of the statistical annex).

Region * KET_categories Crosstabulation

			KET_categories				
			micro/nano electronics	industrial biotechnology	advanced materials	advanced manufacturing technologies	Total
Region	European	Count	2	4	8	21	35
		Expected Count	1,7	6,9	5,7	20,7	35,0
		% within Region	5,7%	11,4%	22,9%	60,0%	100,0%
		% within KET_categories	66,7%	33,3%	80,0%	58,3%	57,4%
	Arabic	Count	1	8	2	15	26
		Expected Count	1,3	5,1	4,3	15,3	26,0
		% within Region	3,8%	30,8%	7,7%	57,7%	100,0%
		% within KET_categories	33,3%	66,7%	20,0%	41,7%	42,6%
Total		Count	3	12	10	36	61
		Expected Count	3,0	12,0	10,0	36,0	61,0
		% within Region	4,9%	19,7%	16,4%	59,0%	100,0%
		% within KET_categories	100,0%	100,0%	100,0%	100,0%	100,0%



Investment capability in euros

The participants were asked how much money (0, 1-5.000, 5.001-10.000, 10.001-15.000, 15.001-20.000, >20.000) they would be willing to invest in novel KET solutions.

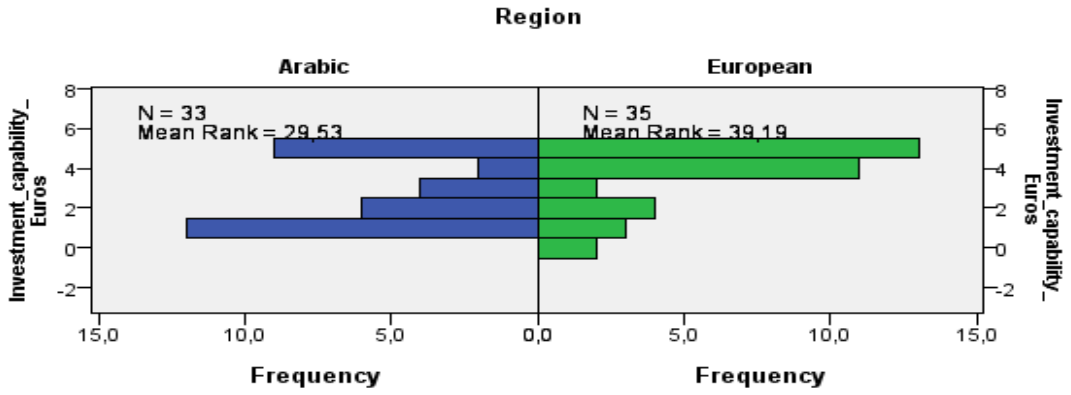
The **investment capability differed between European and Arabic** participants as shown by the Mann-Whitney U Test ($p=0.038<\alpha=0.05$) below. In particular, **the majority of European participants were willing to invest more than 15.000 euros in new KET solutions**. On the contrary, **the majority of Arabic participants were willing to invest less than 10.000 euros** in novel KET solutions, **however a significant proportion** of the interviewed people (27.3%) **were willing to invest more than 20.000 euros.**

Hypothesis Test Summary

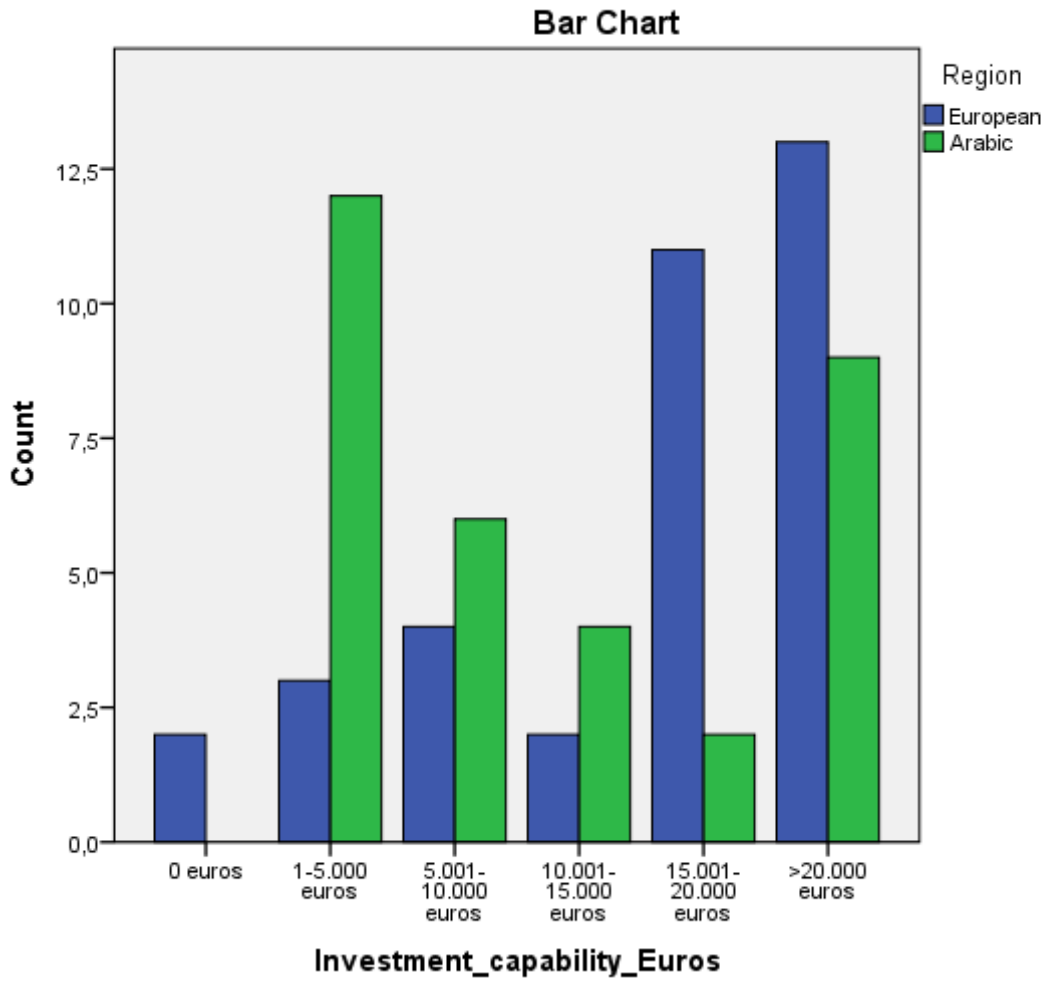
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Investment_capability_Euros is the same across categories of Region.	Independent-Samples Mann-Whitney U Test	,038	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

Independent-Samples Mann-Whitney U Test



Total N	68
Mann-Whitney U	413,500
Wilcoxon W	974,500
Test Statistic	413,500
Standard Error	79,210
Standardized Test Statistic	-2,070
Asymptotic Sig. (2-sided test)	,038



Other information

The mean of the **depreciation years** for investments in new technologies **was 3.89 years for European participants and 3.58 for Arabic participants** (no statistically significant difference). Across both regions, interviewed people were willing to participate in technology transfer projects such as TRANSDAIRY, although the high percentages (approximately 80%) may be biased due to the fact that the interviewees were willing to spend time to answer the questionnaires.

Around 70-80% of the interviewees across Mediterranean identified as critical the following fields that KET solutions could be exploited:

- cutting-edge milking technologies (e.g., robotic milking, sensors in the milking machine, electronic record-keeping etc.)
- tracking of dairy animals and recording of animal health parameters and exploiting data for marketing

- sell/purchase premium quality milk, derived from animals fed functionalized animal feed (e.g., micro-encapsulation of poly-unsaturated fatty acids, natural antioxidant additives, plant extracts etc.)
- sell/purchase milk derived from farms with low methane emissions
- measure milk quality parameters (e.g., pH, SCC, lipid & protein content etc.) from farm to fork without the need for a core laboratory
- incorporation of natural or environmental-friendly and biodegradable substances for disinfection in biosecurity measures (farm or industry level)
- use of novel food additives (e.g., enzymes, yeasts, antioxidants, colorings) for the improvement or creation of new dairy products
- a system for the sensing/recording of safety and quality characteristics of dairy products
- further exploitation of by-products and waste (e.g. energy production, fertilizers etc.)
- ICT data analysis systems or services for transport or logistics
- ICT systems for e-Marketing
- ICT systems/products or services for farm/plant/production/process monitoring and management
- ICT and Internet of Things (IoT) technologies (e.g. robotic milking, sensors in the milking machine, electronic record-keeping etc.)
- deploy Internet of Things solutions to monitor the Cold chain of milk and ensure prime quality for your products
- deploy Block chain solutions to authenticate quality measurements of products through trustworthy third parties
- monitor animal food storage conditions
- exploiting data analysis algorithms to predict animal health, detect faulty conditions in milking and receive predictive maintenance alerts in the production line
- system for the sensing/recording of safety and quality characteristics of dairy products during distribution or marketing

Another interesting finding was that around **60% of interviewees think that the use of novel KET solutions could compromise the characteristics of traditional products,** but were still willing to apply such solutions. Finally **around 70% of participants thought that their personnel would adopt such new KET solutions slowly,** indicating that novel solutions

should be **user-centered and easy to handle to successfully engage the often untrained workers in the DVC.**

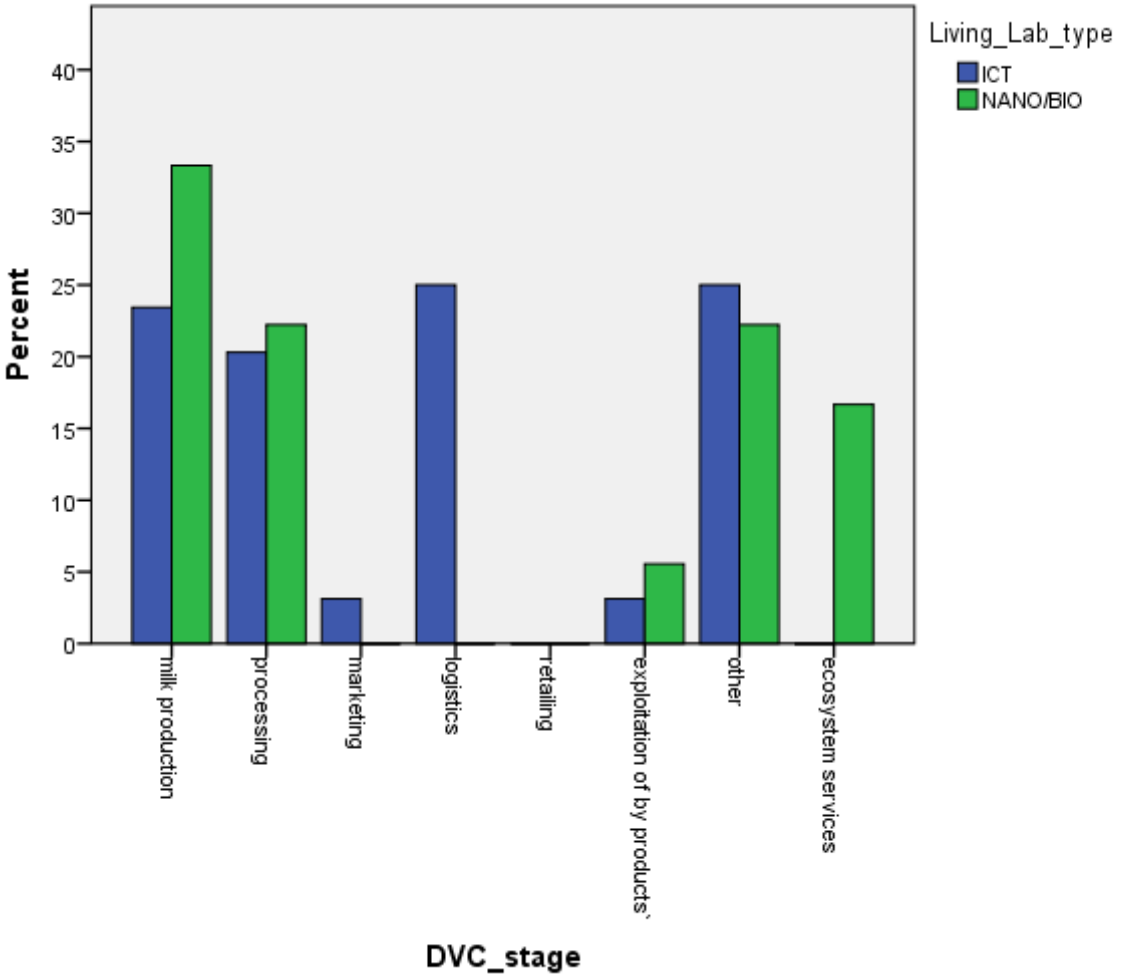
Offer of new KETs solutions

Eighty-two questionnaires (64 ICT, 18 Nano/Bio) for the offer of new KETs across the Mediterranean were collected. The analysis of the questionnaires was conducted on the Living Lab type basis (ICT vs Nano/Bio) to identify the type of the offered technological solutions and investigate if they meet the demand.

In the table below is the distribution of stakeholders in the various stages of the DVC

Living_Lab_type * DVC_stage Crosstabulation

			DVC_stage							
			milk production	processing	marketing	logistics	exploitation of by products `	other	ecosystem services	Total
Living_Lab_type	ICT	Count	15	13	2	16	2	16	0	64
		% within Living_Lab_type	23,4%	20,3%	3,1%	25,0%	3,1%	25,0%	0,0%	100,0%
		% within DVC_stage	71,4%	76,5%	100,0%	100,0%	66,7%	80,0%	0,0%	78,0%
	NANO/BIO	Count	6	4	0	0	1	4	3	18
		% within Living_Lab_type	33,3%	22,2%	0,0%	0,0%	5,6%	22,2%	16,7%	100,0%
		% within DVC_stage	28,6%	23,5%	0,0%	0,0%	33,3%	20,0%	100,0%	22,0%
Total		Count	21	17	2	16	3	20	3	82
		% within Living_Lab_type	25,6%	20,7%	2,4%	19,5%	3,7%	24,4%	3,7%	100,0%
		% within DVC_stage	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%



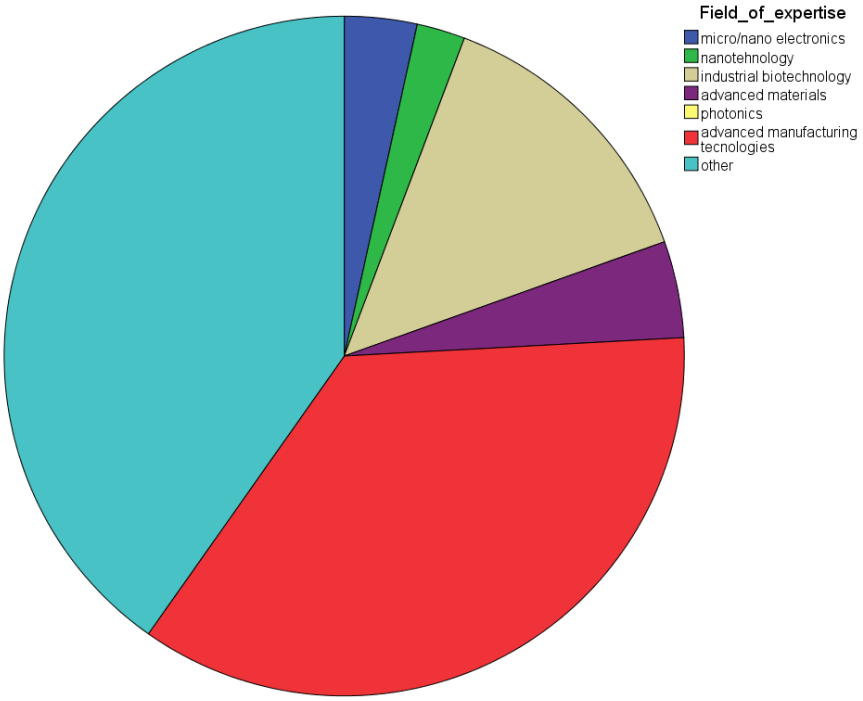
Field of expertise

People participating in the scouting of the offer of new KETs were asked which their field of expertise was. As shown in the table and the pie chart below **the majority (40.2%) of the participants stated other** than KETs followed by **advanced manufacturing technologies (35.6%)** and **industrial biotechnology (13.8%).** This indicates that the providers of technological solutions in the DVC **are focused on two KETs advanced manufacturing technologies and biotechnology. Improving transborder cooperation between DVC stakeholders and exploiting different fields of expertise (including animal experts) could promote the development of novel solutions.**

Field_of_expertise

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	micro/nano electronics	3	3,4	3,4	3,4
	nanotehnology	2	2,3	2,3	5,7
	industrial biotechnology	12	13,8	13,8	19,5

	advanced materials	4	4,6	4,6	24,1
	advanced manufacturing tecnologies	31	35,6	35,6	59,8
	other	35	40,2	40,2	100,0
	Total	87	100,0	100,0	



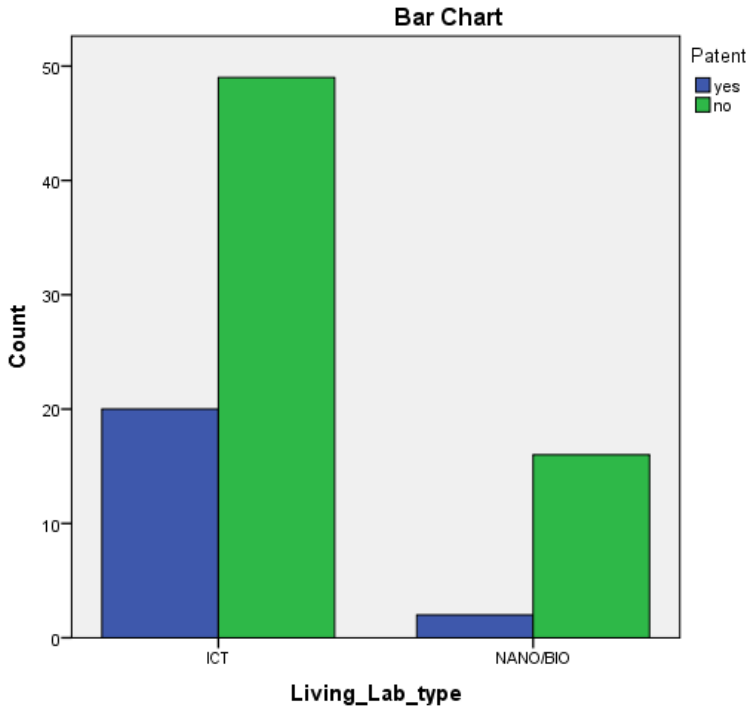
Owning of patents related to the DVC

The participants were asked if they own patents related to the DVC. **The majority of participants did not own patents** (71% ICT and 88.9% Nano/Bio, see table below). However the difference recorded was **not significantly affected by Living Lab type** (chi-square test, $p=0.12>\alpha=0.05$, see the respective section of the statistical annex).

Living_Lab_type * Patent Crosstabulation

			Patent		Total
			yes	no	
Living_Lab_type	ICT	Count	20	49	69
		Expected Count	17,4	51,6	69,0
		% within Living_Lab_type	29,0%	71,0%	100,0%
		% within Patent	90,9%	75,4%	79,3%
	NANO/BIO	Count	2	16	18

	Expected Count	4,6	13,4	18,0
	% within Living_Lab_type	11,1%	88,9%	100,0%
	% within Patent	9,1%	24,6%	20,7%
Total	Count	22	65	87
	Expected Count	22,0	65,0	87,0
	% within Living_Lab_type	25,3%	74,7%	100,0%
	% within Patent	100,0%	100,0%	100,0%



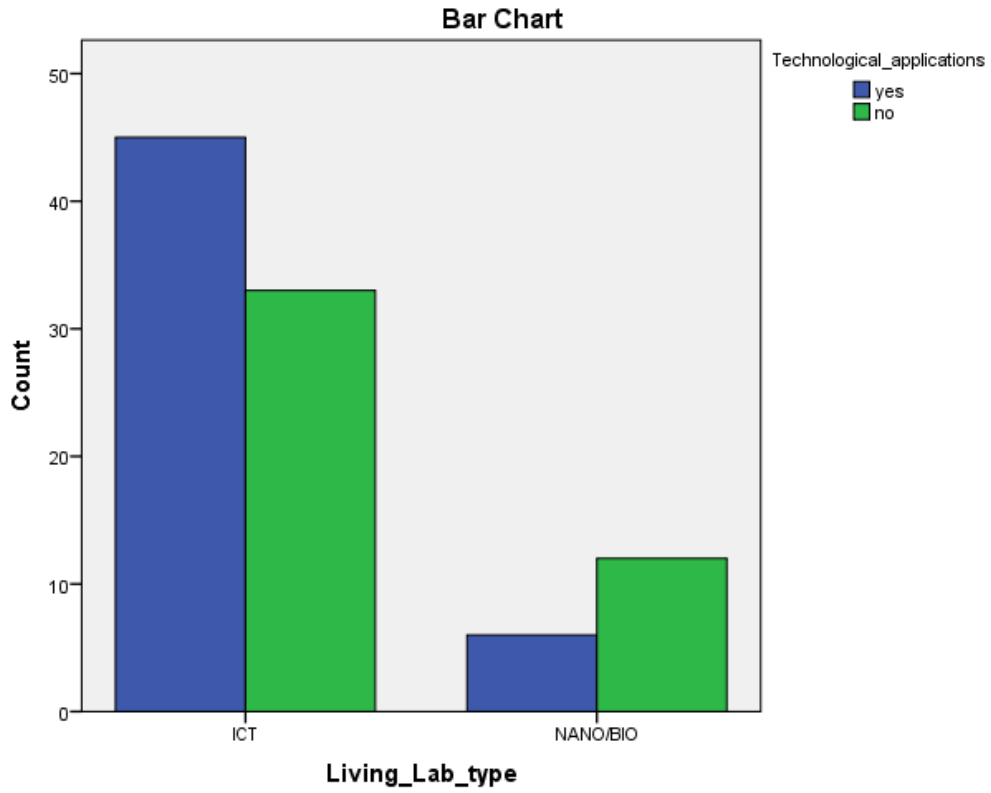
Owning of technological applications related to the DVC

The participants were asked if they own technological applications related to the DVC. **The majority of participants owned technological applications in the ICT** (57.7%) and **the majority of Nano/Bio participants did not own technological applications** (66.7%) (see table below). However the difference recorded was **not significantly affected by Living Lab type** (chi-square test, p=0.062>α=0.05, see the respective section of the statistical annex).

Living_Lab_type * Technological_applications Crosstabulation

			Technological_applications		
			yes	No	Total
Living_Lab_type	ICT	Count	45	33	78
		Expected Count	41,4	36,6	78,0

		% within Living_Lab_type	57,7%	42,3%	100,0%
		% within Technological_applications	88,2%	73,3%	81,3%
	NANO/BIO	Count	6	12	18
		Expected Count	9,6	8,4	18,0
		% within Living_Lab_type	33,3%	66,7%	100,0%
		% within Technological_applications	11,8%	26,7%	18,8%
Total		Count	51	45	96
		Expected Count	51,0	45,0	96,0
		% within Living_Lab_type	53,1%	46,9%	100,0%
		% within Technological_applications	100,0%	100,0%	100,0%



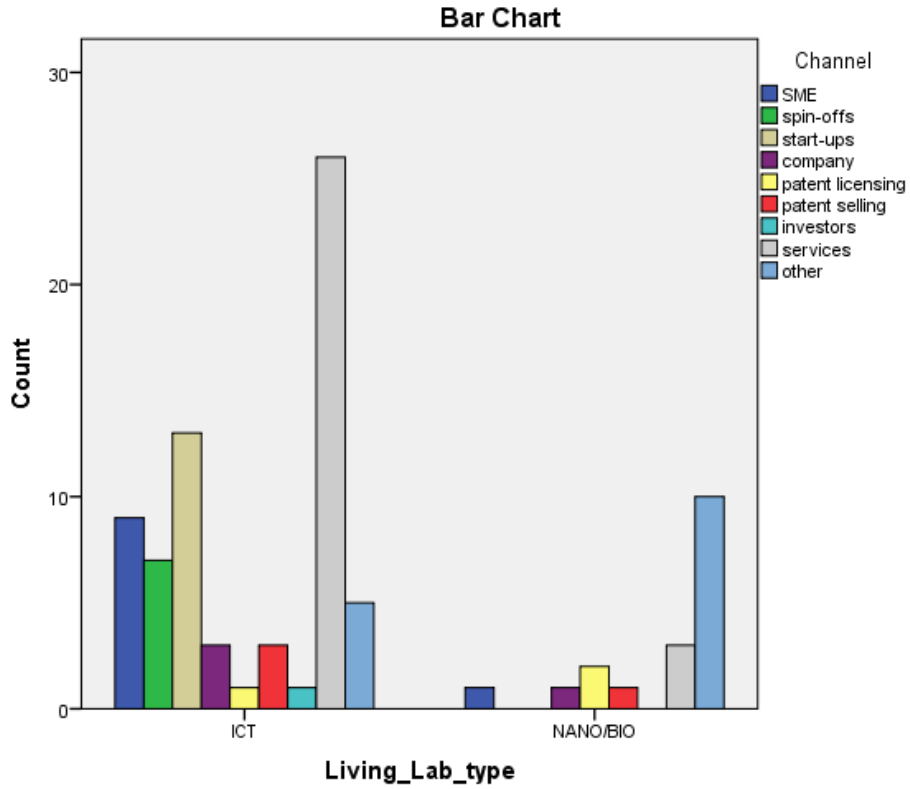
Channeling of technological applications related to the DVC

The participants were asked how they channel their technological applications related to the DVC. **The ICT participants channeled their technological applications to the market differently than Nano/Bio participants** (chi-square test, p=0.0001<α=0.05, see the respective section of the statistical annex). In detail, **ICT interviewees** channeled their

technological application mainly through **selling their services (38.2%), start-ups (19.1%), SMEs (13.2%) and spin-offs (10.3%).** **Nano/bio participants** channeled their technological applications through **other means (55.6%), selling their services (16.7%) and patent licensing (11.1%).** This difference can be explained by the fact that **the majority of Nano/Bio participants were researchers. Phi values were 0.601 indicating a strong positive relationship between Living Lab type and channeling of novel technological solutions.**

Living_Lab_type * Channel Crosstabulation

			Channel									
			SME	spin-offs	start-ups	company	patent licensing	patent selling	investors	services	other	Total
Living_Lab_type	ICT	Count	9	7	13	3	1	3	1	26	5	68
		Expected Count	7,9	5,5	10,3	3,2	2,4	3,2	,8	22,9	11,9	68,0
		% within Living_Lab_type	13,2%	10,3%	19,1%	4,4%	1,5%	4,4%	1,5%	38,2%	7,4%	100,0%
		% within Channel	90,0%	100,0%	100,0%	75,0%	33,3%	75,0%	100,0%	89,7%	33,3%	79,1%
	NANO/BIO	Count	1	0	0	1	2	1	0	3	10	18
		Expected Count	2,1	1,5	2,7	,8	,6	,8	,2	6,1	3,1	18,0
		% within Living_Lab_type	5,6%	0,0%	0,0%	5,6%	11,1%	5,6%	0,0%	16,7%	55,6%	100,0%
		% within Channel	10,0%	0,0%	0,0%	25,0%	66,7%	25,0%	0,0%	10,3%	66,7%	20,9%
Total		Count	10	7	13	4	3	4	1	29	15	86
		Expected Count	10,0	7,0	13,0	4,0	3,0	4,0	1,0	29,0	15,0	86,0
		% within Living_Lab_type	11,6%	8,1%	15,1%	4,7%	3,5%	4,7%	1,2%	33,7%	17,4%	100,0%
		% within Channel	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%



Cost of applying technological solutions in the DVC

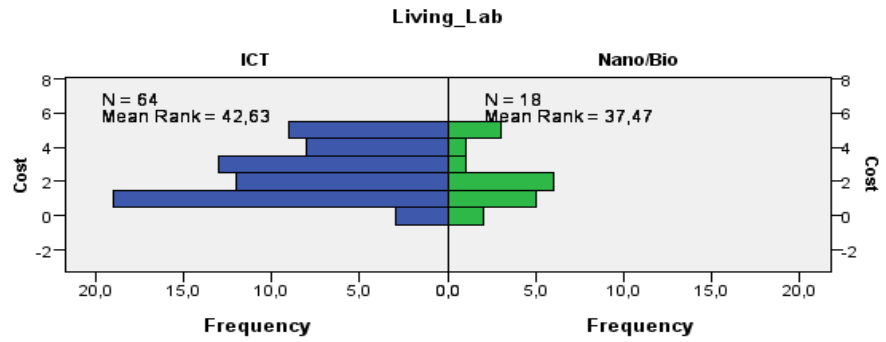
The interviewees were asked about the cost of applying their technological solutions in the DVC. **The distribution of costs did not differ between ICT and Nano/Bio technologies** (Mann-Whitney U test, p=0.406>α=0.05, see the respective section of the statistical annex). **The majority of the technological applications (55.3%) cost less than 10.000 euros.**

Hypothesis Test Summary

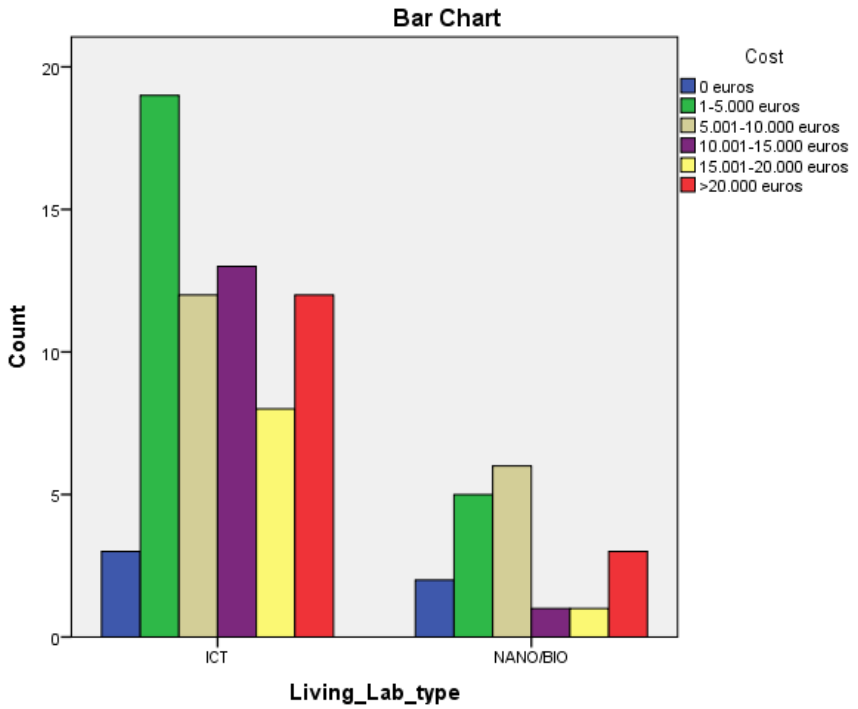
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Cost is the same across categories of Living_Lab.	Independent-Samples Mann-Whitney U Test	,406	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

Independent-Samples Mann-Whitney U Test



Total N	82
Mann-Whitney U	503,500
Wilcoxon W	674,500
Test Statistic	503,500
Standard Error	87,224
Standardized Test Statistic	-,831
Asymptotic Sig. (2-sided test)	,406

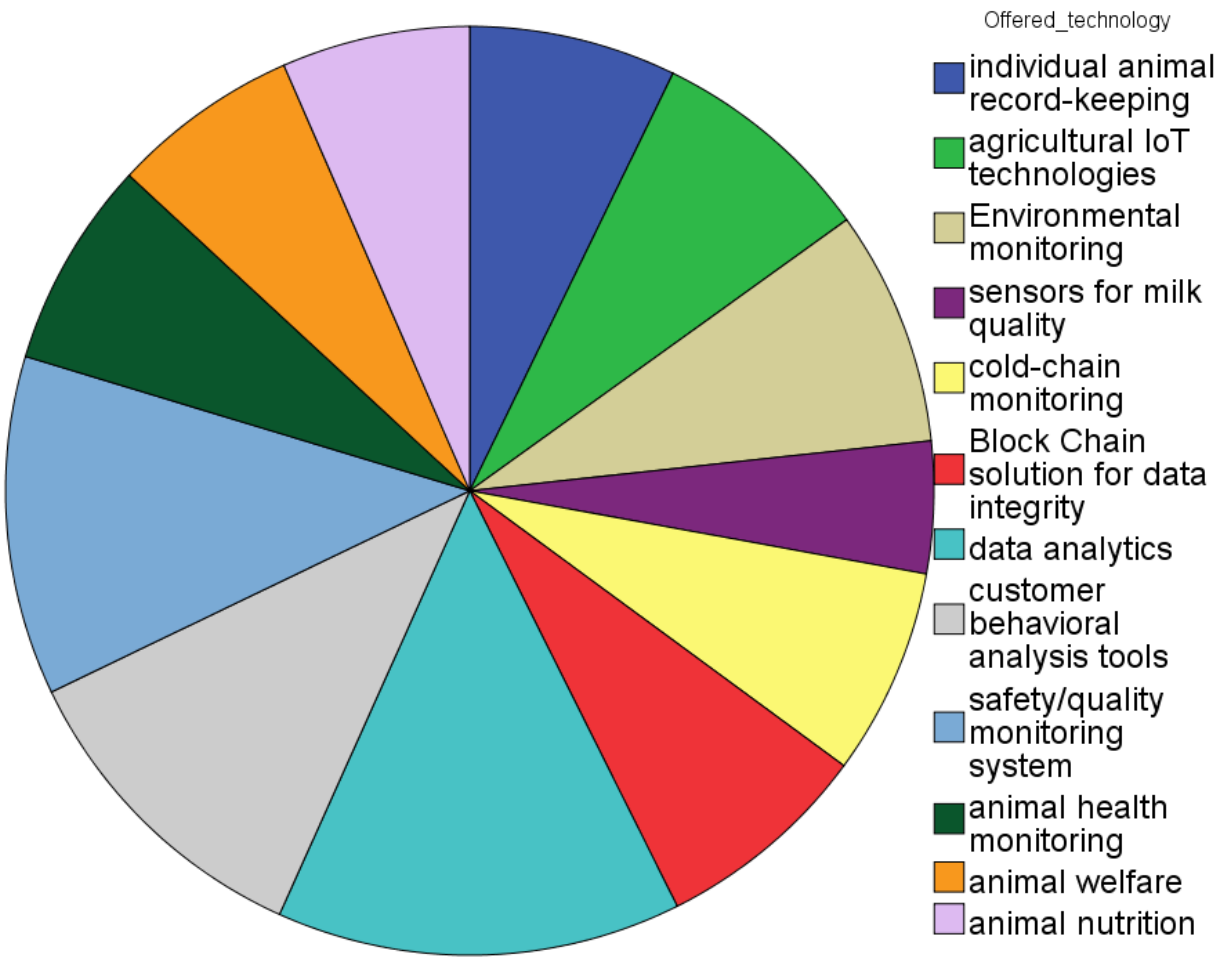


Offered ICT and Nano/Bio solutions

There was a wide range of technological ICT applications offered in the market. **The majority of the ICT technological applications were related to data analytics (14.1%), safety and quality monitoring systems (11.8%) and customer behavioral tools (11.1%).**

Offered_technology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	individual animal record-keeping	22	7,2	7,2	7,2
	agricultural IoT technologies	24	7,9	7,9	15,1
	Environmental monitoring	25	8,2	8,2	23,3
	sensors for milk quality	14	4,6	4,6	27,9
	cold-chain monitoring	22	7,2	7,2	35,1
	Block Chain solution for data integrity	23	7,5	7,5	42,6
	data analytics	43	14,1	14,1	56,7
	customer behavioral analysis tools	34	11,1	11,1	67,9
	safety/quality monitoring system	36	11,8	11,8	79,7
	animal health monitoring	22	7,2	7,2	86,9
	animal welfare	20	6,6	6,6	93,4
	animal nutrition	20	6,6	6,6	100,0
	Total	305	100,0	100,0	

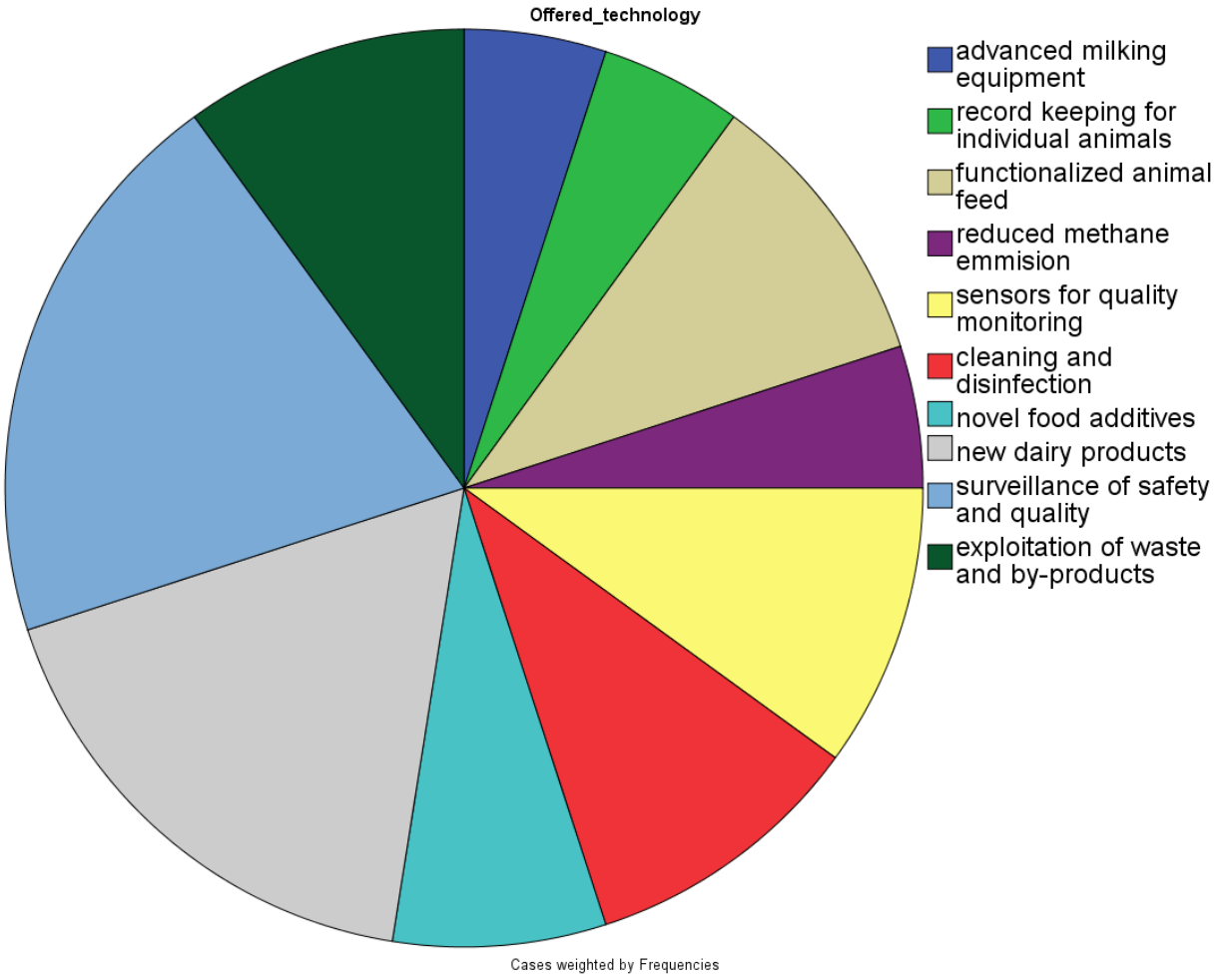


There was a wide range of technological Nano/bio applications offered in the market. **The majority of Nano/Bio technological applications were related to surveillance of safety and quality (20%), new dairy products (17.5%), functionalized animal feed (10%), sensors for quality monitoring (10%), cleaning and disinfection (10%) and exploitation of waste and by-products.**

Offered_technology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	advanced milking equipment	2	5,0	5,0	5,0
	record keeping for individual animals	2	5,0	5,0	10,0
	functionalized animal feed	4	10,0	10,0	20,0
	reduced methane emmision	2	5,0	5,0	25,0

sensors for quality monitoring	4	10,0	10,0	35,0
cleaning and disinfection	4	10,0	10,0	45,0
novel food additives	3	7,5	7,5	52,5
new dairy products	7	17,5	17,5	70,0
surveillance of safety and quality	8	20,0	20,0	90,0
exploitation of waste and by-products	4	10,0	10,0	100,0
Total	40	100,0	100,0	



DISCUSSION

The last decades, there is an increasing demand of animal products due to the growing population. Moreover, natural resources are strained to meet the increased demand. Ruminants, the main milk-producing animals, can thrive in degraded lands and do not directly compete humans for food, as they can exploit poor cellulose-based diets and simultaneously provide products with high nutritional value (milk, meat etc.). In this frame, the livelihoods and food security of millions of people around the globe, especially in developing countries, are directly connected with milk-producing animals and the Dairy Value Chain (DVC). Additionally, modern consumer preferences and food trends have set high quality standards for dairy products. Dairy sector, to successfully respond to these market needs, must optimize productivity, safety and quality assurance of dairy products and promote sustainable development through novel technological solutions.

In this context, we conducted a study in the Mediterranean region using structured questionnaires to identify the demand and offer of new technological solutions and characterize the innovation potential and needs in the DVC. The study was separated in two parts, the demand and the offer of new KET solutions. Across the Mediterranean, DVC stakeholders demand a variety of KET solutions from monitoring & record keeping of animals, animal tracking & feeding, functionalized animal feeds and monitoring of milk quality to novel food additives, ICT & IoT solutions, e-marketing and block-chain solutions for data recording and analysis. The majority of the participants identified advanced manufacturing technologies (60% in European region and 57.7% in the Arabic region) followed by either advanced material (22.9% in European region) or industrial biotechnology (30.8% in Arabic Region) as priorities for novel solutions. Moreover participants stated that novel KET solutions would improve their financial outcome and their current working conditions. However the investment capability differed between European and Arabic participants with the majority of European interviewees being willing to invest more than 15.000 euros in new KET solutions and the majority of Arabic participants being willing to invest less than 10.000 euros. It's worth noting that a significant proportion (27.3%) of the interviewed people (both European and Arabic), were willing to invest more than 20.000 euros. The majority of participants from European countries had invested in novel technologies in their line of work, whereas the opposite was observed in participants from Arabic countries. Finally, 60% of the interviewees think that the use of novel KET solutions could compromise the characteristics of traditional products, but were still willing to apply such solutions. Around 70% of participants thought that their personnel would adopt such new KET solutions slowly.

On the other hand, technology providers have developed solutions relevant to the market needs. ICT solutions focus on data analytics, safety and quality monitoring systems and

customer behavioral tools. Nano/Bio solutions focus on surveillance of safety and quality, new dairy products, functionalized animal feed, sensors for quality monitoring, cleaning and disinfection and exploitation of waste and by-products. In financial terms, the majority of the technological applications (55.3%) cost less than 10.000 euros meeting the investment capabilities of DVC actors. ICT solution providers channel their technological applications to the market differently than Nano/Bio solution providers. In detail, ICT participants channeled their technological application mainly through selling their services (38.2%), start-ups (19.1%), SMEs (13.2%) and spin-offs (10.3%) while Nano/bio participants channeled their technological applications through other means (55.6%, e.g. research results sold to companies), selling their services (16.7%) and patent licensing (11.1%).

The above findings indicate that the market is ready to accept novel technological solutions for a wide range of applications and is also willing to invest in KET technologies at reasonable prices. Moreover, there is currently available a wide range of technological solutions as well as the proper channels for the technology to reach the market. Simply put, the offer of new technological solutions has the potential to meet the increasing demand. Investment capability is directly correlated to the region (European or Arabic). Transborder technology transfer (e.g. through projects such as TRANSDAIRY) and investments (e.g. transborder SMEs) could close this gap and improve the gross income in the Mediterranean region by establishing new trade links. More importantly, providers of novel technological solutions have grasped the modern market needs and requirements and have the means and appropriate channels to provide their products to those who actually need it. However, there is a need for disseminating the novel technological achievements and tools to the wider public, by brining into contact the various stakeholders in the DVC as well as by engaging researchers, policy makers and multidisciplinary teams of experts. The notion that personnel would adopt KET solutions slowly indicates that novel solutions should be user-centered and easy to handle to successfully engage the often untrained workers in the DVC.

Farmers seem to be the most vulnerable stakeholders in the DVC as: i) they have limited direct access to consumers as milk is a product that is consumed fresh and is susceptible to spoilage, ii) their financial outcomes rely on the equilibrium of milk prices and production cost (feed, gasoline and labor costs) in a globalized and often volatile market, iii) have limited investing capabilities and iv) farming has slim profit margins. Considering that farmers are the pillar of the DVC, guarantying their income and livelihoods is the key to the sector's sustainable development. Future actions should be taken to promote the transborder cooperation in the Mediterranean region, facilitate technology transfer and strengthen the skills and financial capabilities of farmers, women and young entrepreneurs.

CONCLUSIONS

The Dairy Value Chain faces a multitude of challenges from sustainability and climate change to productivity and modern consumer trends. To successfully address these challenges DVC has to redefine its structure, priorities and objectives by adopting novel technological solutions. DVC stakeholders are ready to invest in new technologies to overcome modern challenges and at the same time technology providers have developed suitable and solutions and the means to market them. Transborder cooperation and technology transfer programs should be promoted for the wider adoption of novel solutions and reducing inequality in the Mediterranean region.

ANNEX

Demand

Investments in new machines, solutions, ICT, Nano/Bio, services in the last five years

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7,890[a]	1	,005		
Continuity Correction[b]	6,584	1	,010		
Likelihood Ratio	8,068	1	,005		
Fisher's Exact Test				,007	,005
Linear-by-Linear Association	7,775	1	,005		
N of Valid Cases	69				

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 14,78.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	,338	,005
	Cramer's V	,338	,005
N of Valid Cases		69	

Improvement of financial outcome with the application of novel technologies

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2,874[a]	1	,090		
Continuity Correction[b]	1,788	1	,181		
Likelihood Ratio	3,036	1	,081		
Fisher's Exact Test				,151	,089
Linear-by-Linear Association	2,832	1	,092		
N of Valid Cases	68				

Improvement of working conditions with the application of novel technologies

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,668[a]	1	,414		
Continuity Correction[b]	,152	1	,696		
Likelihood Ratio	,681	1	,409		
Fisher's Exact Test				,673	,351
Linear-by-Linear Association	,659	1	,417		
N of Valid Cases	69				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is 2,96.

b. Computed only for a 2x2 table

Previous use of novel technologies in the DVC

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,032[a]	1	,858		
Continuity Correction[b]	,000	1	1,000		
Likelihood Ratio	,032	1	,858		
Fisher's Exact Test				1,000	,529
Linear-by-Linear Association	,032	1	,859		
N of Valid Cases	68				

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 11,65.

b. Computed only for a 2x2 table

Importance of KET categories

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5,049[a]	3	,168
Likelihood Ratio	5,226	3	,156
Linear-by-Linear Association	,215	1	,643
N of Valid Cases	61		

a. 3 cells (37,5%) have expected count less than 5. The minimum expected count is 1,28.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	,288	,168
	Cramer's V	,288	,168
N of Valid Cases		61	

Offer

Owning of patents related to the DVC

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2,414[a]	1	,120		
Continuity Correction[b]	1,561	1	,212		
Likelihood Ratio	2,755	1	,097		
Fisher's Exact Test				,142	,102
Linear-by-Linear Association	2,386	1	,122		
N of Valid Cases	87				

Owning of technological applications related to the DVC

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3,485[a]	1	,062		
Continuity Correction[b]	2,575	1	,109		
Likelihood Ratio	3,517	1	,061		
Fisher's Exact Test				,072	,054
Linear-by-Linear Association	3,448	1	,063		
N of Valid Cases	96				

Channeling of technological applications related to the DVC

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	31,076[a]	8	,000
Likelihood Ratio	30,537	8	,000
Linear-by-Linear Association	8,240	1	,004
N of Valid Cases	86		

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	,601	,000
	Cramer's V	,601	,000
N of Valid Cases		86	

Cost of applying technological solutions in the DVC

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4,867[a]	5	,432
Likelihood Ratio	5,064	5	,408
Linear-by-Linear Association	1,065	1	,302
N of Valid Cases	85		