



SABRE

CUTTING EDGE GENOMICS FOR SUSTAINABLE
ANIMAL BREEDING

**The additional value and impact achieved by the SABRE project exceeding the original
scientific and economic objectives**

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A summary report entitled “At the cutting edge” is available in which the key findings of this report are detailed.

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Glossary

EU associated countries - Albania, Bosnia, Croatia, Faroe Island, Former Yugoslav Republic of Macedonia and Serbia, Herzegovina, Iceland, Israel, Liechtenstein, Montenegro, Norway, Switzerland, Turkey

EU-15 member states - Austria, Belgium, Denmark, Finland, France, Germany, Greece, Hungary, The Irish Republic, Italy, Luxembourg, Malta, Netherlands, Portugal, Spain, Sweden, UK

n – number of individuals

NMS – New EU member states - Bulgaria, Cyprus, Czech Republic, Hungary, Lithuania, Latvia, Malta, Poland, Romania, Slovenia, Slovakia

OMG – Operational Management Group

SABRE – Cutting Edge Genomics for Sustainable Animal Breeding

WP – Work package



At the Cutting Edge

Summary

SABRE – Cutting Edge Genomics for Sustainable Animal Breeding is a €23 million pan-European Integrated Project which has brought together almost 200 scientists from 14 countries, including international areas. A great number of scientific advances have been achieved by SABRE harnessing key areas of genomics and epigenetics. Scientific breakthroughs include the complete sequencing of two priority pig chromosomes, significant progress towards the elimination of boar taint and significant advances towards eggshell quality enhancement. These crucial discoveries will enable animals to be produced that are healthier, less reliant on drug treatments, more resistant to diseases and disorders, and able to produce better quality food. A great deal of added value and leverage has been achieved by the SABRE project which has not been captured by the normal EU project reporting procedures and scientific publications. These added impacts demonstrate the successes achieved by the project and more generally ascertain the ‘additional’ benefits of EU research funding. New research opportunities in addition to novel approaches and personal skills have been acquired, a vast array of partnerships and collaborations have been formed furthermore new funding opportunities have been obtained by various organisations due to (or partly because of) an involvement or association with the project.

1. Background

SABRE – Cutting Edge Genomics for Sustainable Animal Breeding is an innovative four-year, €23 million pan-European Integrated Project which combines contributions from international areas. Thirty six European and world leading research and industry centres in the field of animal production and breeding joined forces in SABRE to build upon their combined expertise, resources and co-funding contributions. SABRE was designed in order to provide a range of new breeding strategies to improve animal health and welfare; reduce chemical and energy inputs; minimise livestock waste and pollution; and, maximise food safety and quality whilst maintaining biodiversity and economic sustainability. As a result, safe and high-quality foods that are in line with consumer expectations and European Policy have been delivered.

SABRE’s accomplishments have gone above and beyond the scientific advances gained in the field of food security. Many significant impacts and additional benefits have been achieved by the SABRE project, beyond those originally captured by the normal EU project reporting procedures and scientific publications. These added impacts demonstrate the successes achieved by the project and more generally ascertain the ‘additional’ benefits of EU research funding. New research opportunities in addition to novel approaches and personal skills have been acquired, a significant and diverse number of partnerships and collaborations have been formed furthermore new funding opportunities have been obtained by various organisations due to (or partly because of) an involvement or association with the project.

The work programme involved approximately 200 scientists from 14 countries and divided into 13 research, development and communication work packages (WPs) (Figure 1). Nine of these countries are within the European Union (Denmark, Finland, France, Germany, Italy, Netherlands, Poland, Spain, United Kingdom). The non-EU countries (Brazil, China, Israel, Norway and Switzerland) are all represented by academic organisations. A table of all SABRE Integrated Project partners is illustrated in APPENDIX 1, table 1. EU countries are represented by both academic and industrial organisations. Key areas of emerging genomic and epigenetic science were harnessed in order to generate new knowledge and apply it in practical breeding improvement strategies throughout Europe.

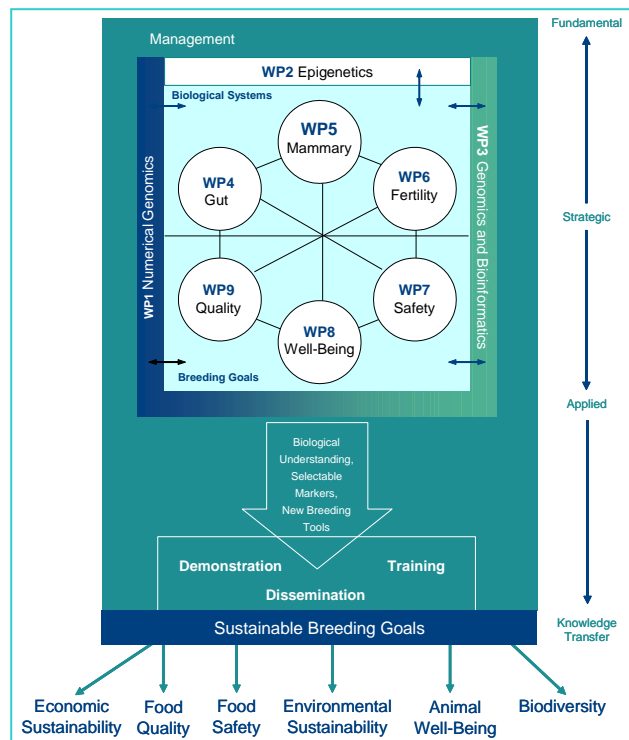


Figure 1. The structure of SABRE

2. SABRE technology development

The approach utilised by SABRE united the power of recent developments in genomics to determine the origin of genetic variation in key quality, safety and sustainability traits in the most important farmed animal species (cattle, poultry and pigs). Research was grouped into three areas spanning research from the fundamental to the relatively applied: development of underpinning technologies and knowledge, understanding of the genomics of key biological systems, and focused breeding goals directly relevant to sustainability issues.

The innovative targets for livestock breeding employed by SABRE included quality and disease resistance and other welfare related traits. These traits have low heritability's or may be difficult or expensive to measure therefore have proven more difficult to develop than standard production traits using traditional selection and crossbreeding tools. The direct identification of animals that are carrying the desired genetic variants, rather than relying on imprecise information from performance testing, enabled animals to be identified for selection before traits of interest had been expressed. Animals could thus be selected early in life with no need to challenge with disease, or slaughter to collect meat quality data. The SABRE project applied an array of genomic tools, appropriate populations and trait records in order to improve livestock sustainability through genomic selection. The use of high throughput genetic and functional tools combined with appropriate populations and data, and bioinformatic and numerical support infrastructure unlocked the possibility for efficient and effective identification of genes that could be utilised in sustainable farm animal breeding programmes.

Further important objectives of the SABRE project included demonstrating the effectiveness of sustainable breeding genomics and the dissemination of existing knowledge and new results to relevant research programmes, policy customers and potential end-users using Knowledge-Transfer skills. The launch of the SABRE website, the SABRE Launch event and the subsequent five conferences and press releases, in addition to the SABRE newsletter, have been successful in widening project awareness and enforcing the excellent contacts that have been created. Skills and training have also been developed in order to capitalise on new genomics knowledge thus spreading best-practice within SABRE and the wider European community, particularly new EU member states (NMSs) and INCO countries, and improving competitiveness and more sustainable food production from farmed livestock. Training has proven beneficial for the integration of different WPs and organisations within SABRE.

3. Consortium Management

A robust and transparent management structure and decision-making process was utilised in order to achieve the project goals and the level of integration required between diverse research areas and partners (Figure 2). SABRE has 4 hierarchical levels of management. The Board is the central decision making forum for SABRE and is supported by the Operational Management Group (OMG) which is underpinned by 13

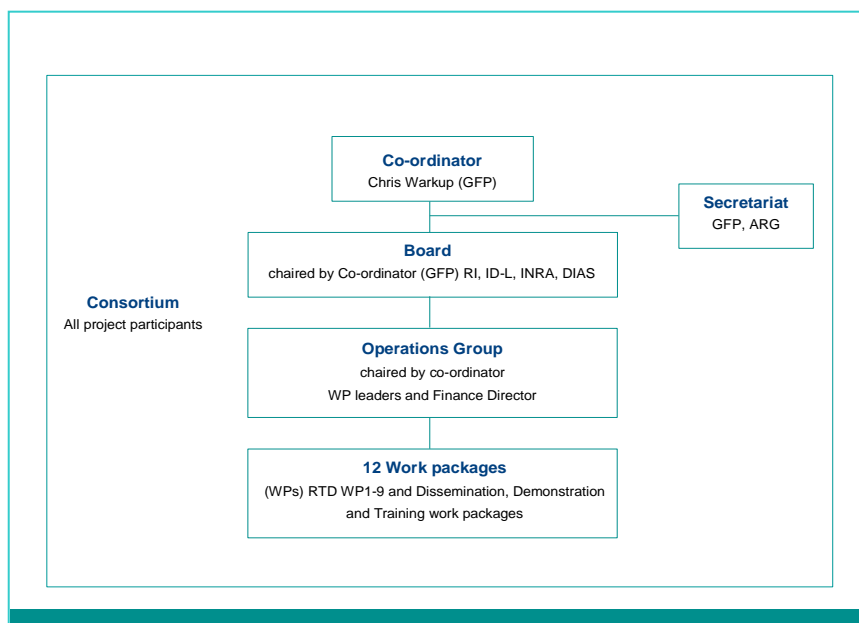


Figure 2. SABRE Management Structure

research, development and communication packages. The OMG was intended to effectively identify problems and agree solutions at an early stage to enable project deliverables to be achieved, thus provide benefits to the project as a whole. Delays in the initiation of activity were expected to be minimised in addition to the appointment of new staff. All participants were represented in these WPs, where all technical activities on a day-to-day basis were managed. WPs comprised of a WP Leader, generally a representative from the Board of participants, plus the designated lead scientist, who is responsible for each participant's contribution to their respective WPs. The Board is chaired by Chris Warkup (BKTN) and also includes representatives from UEDIN, ASG-Lelystad, INRA and AU.

4. Investigating the Additional Values and Impacts

The SABRE Impact and Added Value Assessment questionnaire was constructed in order to assess the significant impacts and additional benefits achieved by the SABRE project, beyond those

originally designated as SABRE objectives and captured by the normal EU project reporting procedures and scientific publications. Individuals within the 4 hierarchical levels of SABRE management were contacted in order to request completion of the questionnaire, including all Board members, members of the OMG, WP Leaders and scientists. In addition, attendees of SABRE conferences, newsletter subscribers and SABRE funded placement participants were contacted in order to obtain a broad range of opinions and views of the overall added benefits and impacts of the SABRE project. This enabled the previously unreported advances and additional improvements produced by the project to be deciphered. (See Appendix 1, table 2 for statistics on those contacted).

A selection of individuals were then interviewed using criteria such as geographical location, the involvement of the individual with the SABRE project and the seniority of the individual's position within SABRE in order to gain information and opinions from those involved in all aspects of SABRE. This permitted the SABRE Impact and Added Value Assessment report to take account of all the features the SABRE project had to offer. Individuals not directly involved in SABRE, but who had expressed an interest either through subscription to the SABRE newsletter or through attendance at SABRE conferences, were consulted from globally diverse locations to gain as wide-ranging a response as possible. In addition, SABRE funded placement participants provided a detailed perspective of their experience with the SABRE project and the additional benefits they may have gained. Board members and the lead contacts from a variety of organisations within the SABRE consortium were also consulted as a means of following up on comments and answers expressed in the questionnaire.

Organisations originating from NMSs including Bulgaria and international locations such as China and Brazil were also involved in the SABRE project. Interviews were conducted with a number of individuals from these aforementioned regions in order to gain more detailed information with regards to the questionnaire content.

5. The Findings – where the added value and leverage lies

An extensive range of benefits have been obtained by all those involved with SABRE and have provided advantages exceeding the objectives originally required to be fulfilled by the project. It must be acknowledged that a margin of error should be taken into account with respect to the results obtained through analysis of the questionnaire responses as a number of the individuals who have completed the questionnaire do not possess English as their foremost language.

5.1 The value of SABRE's contribution to research institutes

Academic organisations (universities and research institutes), which include Aarhus University; the Agricultural Research Organisation, the Volcani Centre; the Institut National de la Recherche Agronomique and ASG Lelystad, comprise over half of SABRE's consortium members. The responses obtained from individuals within such organisations is thus of high significance. A predominantly positive outlook has been expressed in relation to the contribution SABRE has provided to these organisations, with 80% indicating that value has been added.

When evaluated more closely it could be observed that 53% of individuals from academic organisations who completed the SABRE impact and added value assessment questionnaire rated SABRE’s contribution to their organisation of strong value and in 6% of cases indispensable, with 21% believing SABRE at least contributed some value. This positive trend was observed over the majority of academic organisations within the SABRE consortium and also those not directly involved in the project, such as the National Research Centre in Egypt, thus highlighting the positive impact SABRE has created for all organisations associated with the project.

5.2 The value of SABRE’s contribution to small and medium enterprises

The SABRE consortium included a number of small and medium enterprises (SMEs) including Argentix, Biosciences KTN and the Institute for Pig Genetics. In addition, small and medium organisations such as Stonebridge Breeding based in the UK and Eversole Associates based in the

USA have associated with SABRE through attendance at SABRE events or utilisation of the SABRE website.

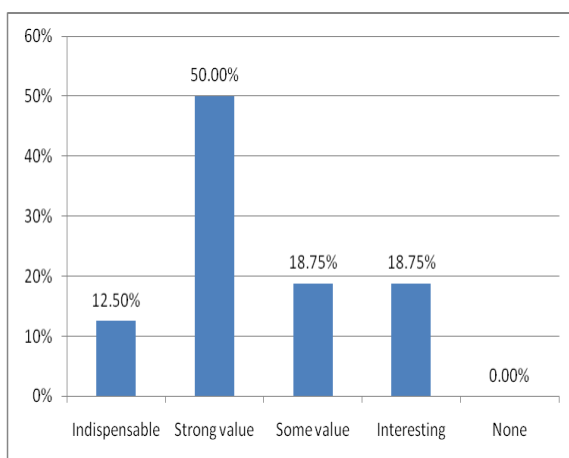


Figure 3. The degree of value that SABRE has contributed to SME’s, both within or associated with SABRE ($n=16$).

The evaluation of answers provided by the questionnaire has revealed that 50% of individuals from SME’s directly involved with SABRE would regard the project as contributing strong value to their organisation with 12.5% indicating that this value was indispensable to their organisation. Additionally, 75% of SME’s who were not directly involved in SABRE but had either participated in a placement or attended a SABRE event considered SABRE’s contribution to their organisation to have provided at least some value.

5.3 Additional benefits gained by Chinese organisations associated with SABRE

Three organisations based in China are members of the SABRE consortium: China Agricultural University, Zhejiang University and JiangXi Agricultural University. Placements funded by SABRE were also undertaken by individuals of Chinese nationality from academic organisations such as Huazhong Agricultural University. It was revealed that all individuals from these organisations, who completed the questionnaire, believed that their involvement with the SABRE project has contributed some value towards their organisation.

To further highlight the added benefits gained by Chinese organisations, as a direct result of an association or involvement with the project, a number of collaborative links have been achieved. It was revealed that new partnerships have arisen between Huazhong Agricultural University and other organisations within SABRE. In addition new partnerships have arisen between Zhejiang University and organisations from both within and outside SABRE.

5.4 SABRE's scale and complexity - beneficial or detrimental?

The benefits gained through SABRE's scale and complexity has been an area of debate as issues surrounding the limited international communication within and between WPs and between partners of the consortium has led to possible difficulties. Language barriers provided a key source of concern due to the prospect of restricting collaborations between countries. Additionally, SABRE's vast consortium size, in contrast to financial magnitude, was considered of less importance with regards to the leverage and additional benefits achieved, due to the less significant position and responsibility of several partners within the consortium.

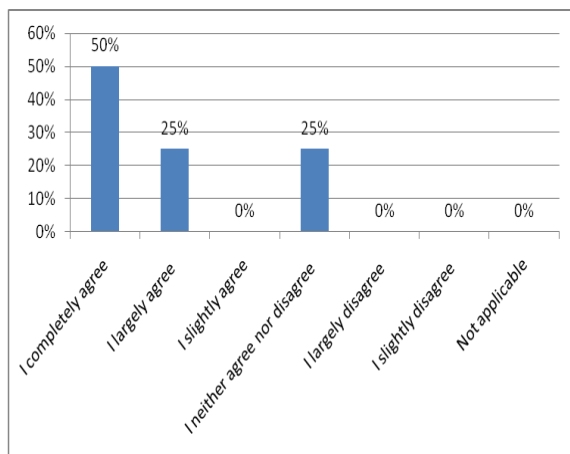


Figure 5. Responses of individuals from Chinese organisations, both within or associated with SABRE, to the statement 'My activities within the SABRE project benefitted from the fact that SABRE was a large and diverse research project'. The 25% of respondents who neither agreed nor disagreed were not members of the SABRE consortium ($n=4$).

Furthermore, 66% of questionnaire respondents, all of whom had an association with SABRE, agreed that their activities within the project had benefitted from the fact that SABRE was large and diverse. 3/4 of individuals from Chinese organisations, who were either within the SABRE consortium or had an association with the SABRE project, also considered their activities within SABRE to have benefitted from the fact that SABRE was a large and diverse research project.

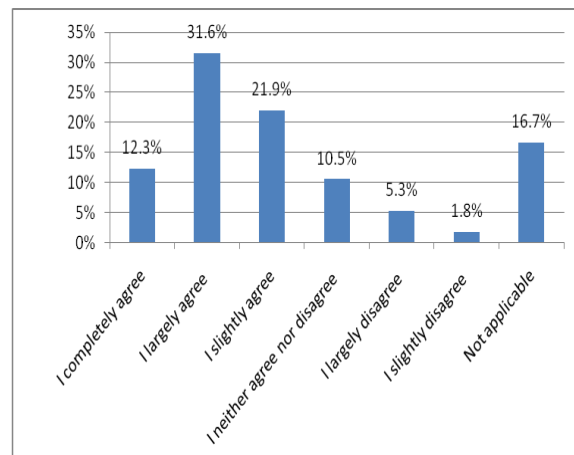


Figure 4. Responses of individuals, both within or associated with SABRE, to the statement 'My activities within the SABRE project benefitted from the fact that SABRE was a large and diverse research project'. 30% of those non-applicable to the statement were from NMSs and 25% were from countries outside the European Union such as Bhutan.

On the contrary, SABRE's large scale has provided critical added benefits to organisations that participated in or were associated with the project with a smaller project possibly not achieving such an overall beneficial impact. The extensive size of SABRE enabled the project to gain an extensive profile which in turn raised the reputation and visibility of SABRE associated organisations within Europe. Many project scientists agreed that the large scale, which united so many countries, laboratories and experiences, was vital to the

5.5 SABRE funded placements – another string to SABRE's bow

SABRE funded placements were undertaken by individuals from a wide array of countries including European Union associated countries such as Croatia and Israel, EU-15 member states such as Germany and the Netherlands in addition to NMSs (ie Bulgaria) and countries outside Europe, for example Egypt and China. The diverse assortment of nationalities who took part in a SABRE placement emphasises the high profile and visibility this project has achieved. Individuals internationally are widely aware of SABRE and its reputation, in turn deciding to partake in a SABRE funded placement with the confidence that it would provide them with new scientific contacts, skills and the opportunity to be mentored by scientists who excel in their field.

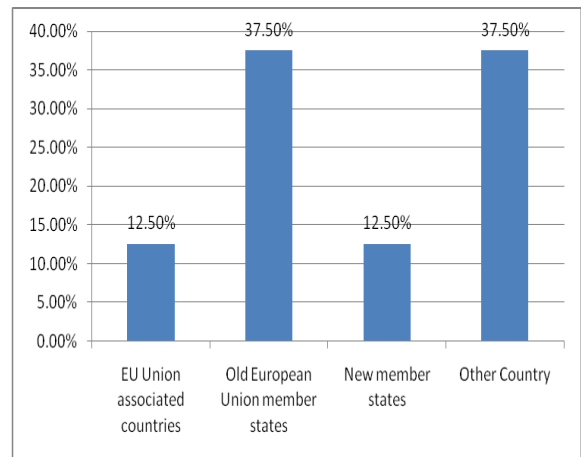


Figure 6. The variety of countries in which individuals who took part in a SABRE funded placement originated ($n=16$). Data was obtained from respondents to the SABRE impact and added benefits assessment questionnaire.

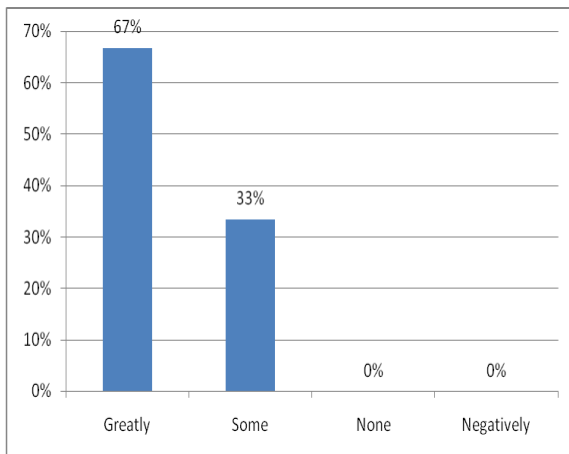


Figure 7. The degree to which participation in a SABRE placement has impacted on the individuals research, organisation or career ($n=13$).

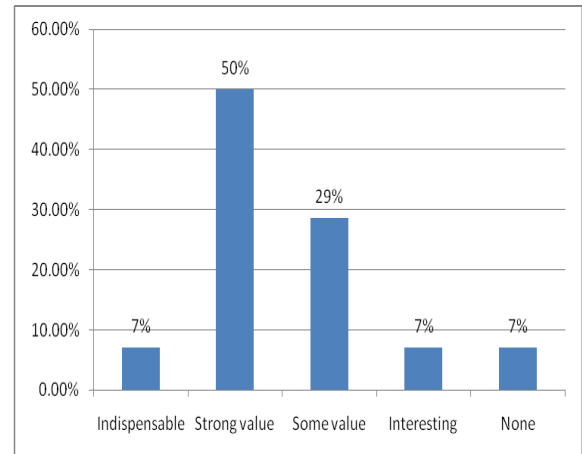


Figure 8. The degree of value that SABRE has added to the organisation of individuals who undertook a placement funded by SABRE.

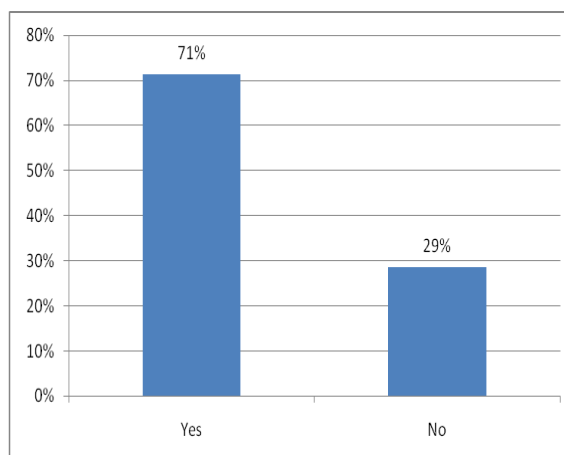


Figure 9. The placement participants who attended SABRE conferences or workshops ($n=14$).

All placement participants who responded to the questionnaire indicated that SABRE has produced an impact upon themselves or their organisation with 57% indicating that strong or indispensable value has been added. These positive findings are further corroborated by the responses of placement participants from NMSs such as Bulgaria, who indicated that SABRE has added value and in some instances indispensable value to their organisation. Furthermore such participants have indicated that they have gained new partnerships with organisations both within and outside the SABRE consortium as a direct result of an association or involvement with the SABRE project.

Thanks to the funding of placements and the enhancement of travelling opportunities, SABRE has enabled participants to be encouraged and mentored by leading scientists. The acquisition of new skills and techniques has resulted in the advancement of participant’s research and that of their organisation through the conveyance of novel working methods to colleagues. Personal abilities have also been developed, such as the learning of new languages, which may increase opportunities to form new collaborations and contacts with individuals and organisations from international countries. Furthermore conferences and workshops were attended which would not have been possible without the placement opportunity created by SABRE. Of the 71% who attended such conferences/ workshops, 60% went on to acquire and subsequently act upon information presented by the external speakers

5.6 The core areas of added value

The variety of additional value SABRE has added to consortium partners and organisations associated with SABRE was categorised in order to identify areas where SABRE has contributed most greatly.

It has been repeatedly emphasised by a wide-ranging cohort of individuals from all areas of SABRE, from board members and WP leaders to those associated with SABRE through only newsletter subscription, that new and diverse opportunities within and between organisations have been

enhanced greatly. Additional opportunities for organisations and individuals outside SABRE to participate in international meetings and communicate with top researchers have been created. The acquisition of external funding has also been highlighted as an advantage gained through an association with SABRE. The SABRE project has provided an opportunity to work on research projects that otherwise would not have been funded through the enhanced leverage and impact created by the involvement of the European Commission and DG research.

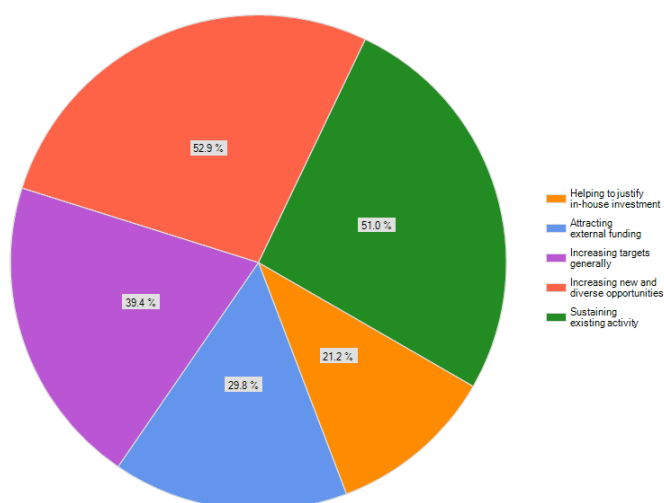


Figure 10. The type of value SABRE has added to individuals both within or associated with SABRE ($n=134$).

Individuals located in NMSs recognised areas such as the meeting of targets, gaining new and diverse opportunities and the sustaining of current activity to have received the greatest value from SABRE. The greatest value gained by Chinese partners who responded to the survey appears to be the sustaining of existing activity followed by an increase in targets and increased new and diverse opportunities.

5.7 The new EU member states – opportunities and benefits beyond the expected

It was deciphered that 100% of respondents from NMSs including Bulgaria, Hungary, Poland and Slovakia deemed their involvement in the SABRE project to be beneficial to their own or their organisation’s profile and reputation (in addition to that obtained from scientific publications). All the aforementioned respondents utilised the SABRE website, attended SABRE events or took part in a SABRE funded placement. They were not direct members however of the SABRE consortium. This emphasises the far reaching impact and leverage produced by this global project and the scientific links that have been strengthened between NMSs and key organisations within SABRE. This has improved the scientific credibility of NMSs who have previously been considered less well engaged in the project. Furthermore, the networking opportunities provided by SABRE for scientists from NMSs to interact with leading scientists from Europe has enhanced the reputation and positive profile of such organisations within the European and global food security arena.

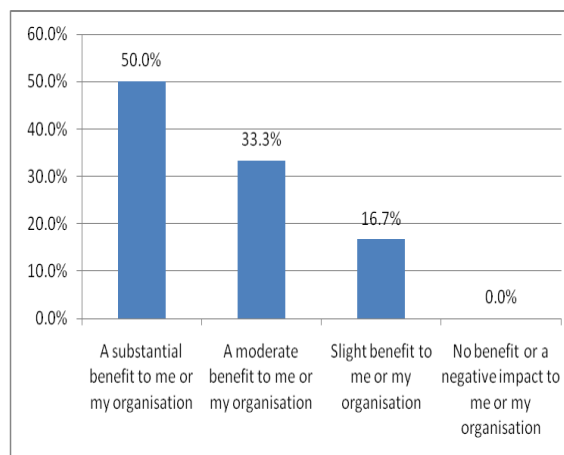


Figure 11. The degree of benefit produced by SABRE to individuals from NMSs including Bulgaria, Hungary, Poland and Slovakia and their organisation’s profile and reputation (in addition to that obtained from scientific publications) ($n=8$).

5.8 Changes to food security policy – the impact of SABRE research and results

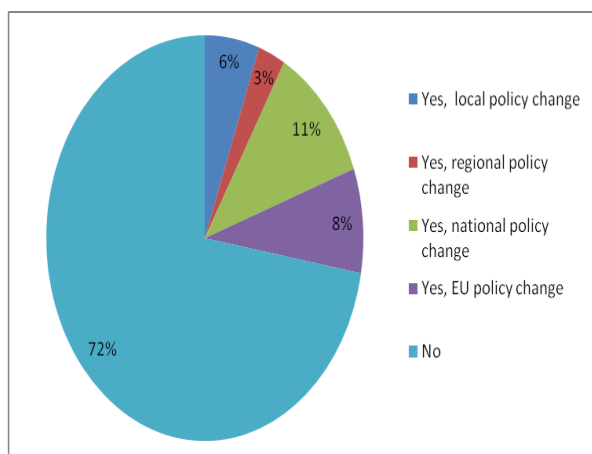


Figure 12. The awareness of any changes to policy (that have or are likely to be implicated) as a result of SABRE research ($n=134$).

The scientific research and results produced by the SABRE project has had far reaching effects facilitating vast advances in the field of food security. By providing a range of new breeding strategies, the health and welfare of animals has been improved, chemical and energy inputs have been reduced with food safety and quality also being maximised in addition to a range of other environmental and economical impacts. The question however remains as to whether these important scientific developments have been translated in to policy changes and whether there is wide awareness of this among the scientific community.

28% of individuals surveyed are aware of a change to policy resulting from the scientific results produced through SABRE’s research. 60% of survey respondents from NMSs however indicated that they were aware of a national policy change that has or is likely to be implicated as a result of SABRE research. An example is the Hungarian Platform for Sustainable and Integrated Sheep Breeding which was established by Hungarian Researchers supported by a Hungarian grant agency (NKTH). Awareness of local, regional and EU change was also stated by other individuals from NMSs. It has also been highlighted that SABRE research focussing on the elimination of boar taint in pig meat is likely to influence decision-making related to EU policy regarding the castration of piglets.

5.9 The facilitation of collaborations and partnerships – a fundamental additional value

SABRE has given rise to a significant number and diversity of partnerships and collaborations that would not have come into existence in the absence of this project. These collaborations have

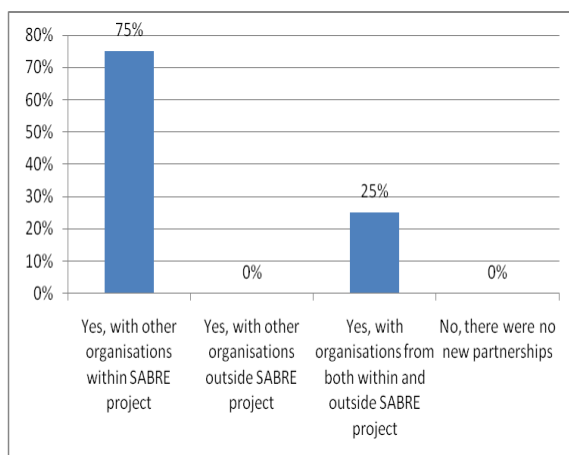
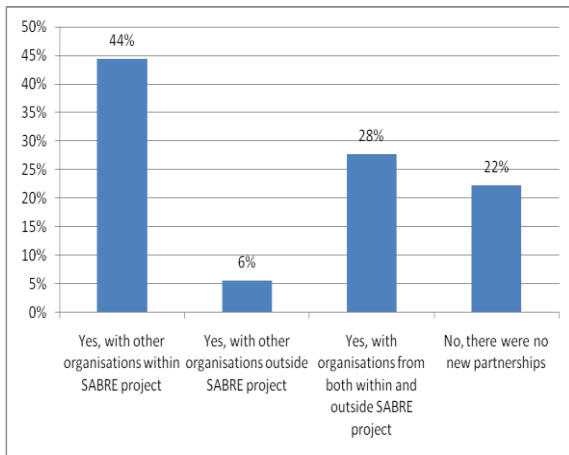


Figure 13. New partnerships that WP leaders consider to have arisen between their organisation and others as a direct result of involvement with the SABRE project ($n=12$).

involved organisations within the SABRE consortium and those outside, who may have become associated with the project through its high profile and global visibility. This statement has been corroborated by a broad spectrum of individuals who were surveyed, for example, 100% of WP leaders who completed the questionnaire consider new partnerships to have arisen as a direct result of involvement with the project, with 25% indicating partnerships have arisen with organisations both within and outside the SABRE consortium.

At least two FP7 funded projects, Quantomics and 3SR, have arisen as a direct result of activity developed within SABRE, highlighting the strength of networking and partnerships that have been achieved. The SME, Biosciences KTN, has indicated that the SABRE project has provided their business with over €400,000 of new income. In addition, a number of SABRE partners have benefitted from Marie Curie Host Fellowships for Early Stage Research Training applications associated with SABRE or as a result of Biosciences KTN’s experience with SABRE and the Marie Curie project “SABREtrain”. International linkages beyond the EU have been increased, with examples involving SABRE associated organisations such as Biosciences KTN and the US Department of Agriculture which has in turn augmented the EU/US task force on Biotechnology.

As a whole, 78% of participating scientists consider new partnerships to have arisen through the direct involvement of their organisation in the SABRE project. An example to illustrate this additional value has been obtained from scientists within WP3, Genomics and Bioinformatics, who have indicated that greater partnerships have been encouraged within Europe. Additionally, as part of the (global) pig sequencing consortium, SABRE has contributed to the formation of good relations around the world.



To further confirm the positive impact SABRE has created in relation to novel collaborations between organisations, 57% of respondents who took part in a SABRE funded placement thought that new partnerships had arisen between organisations through an association or involvement with the SABRE project. Of these, 23% thought that these new collaborations had occurred between organisations both within and outside SABRE.

Figure 14. New partnerships that scientists participating in SABRE consider to have arisen between their organisation and others as a direct result of involvement with the SABRE project ($n=18$).

5.10 The added value of SABRE events

The purpose of SABRE events such as conferences and workshops was to provide wide awareness of the project and improve the direct-transfer of knowledge to relevant organisations both within and outside the SABRE consortium. Information and developments from within the project were also intended to be circulated to relevant end-users and policy customers. In addition, by inviting key external speakers to annual SABRE conferences it was proposed that updates on relevant external science would be provided, especially from other major projects including EADGENE. Furthermore discussion of the wider societal implications of the project was hoped to be broadened.

63% of individuals associated with SABRE through newsletter subscription or attendance at SABRE events and 60% of individuals involved with the overall project management have acquired information following their attendance at SABRE conferences or workshops which they have subsequently acted upon.

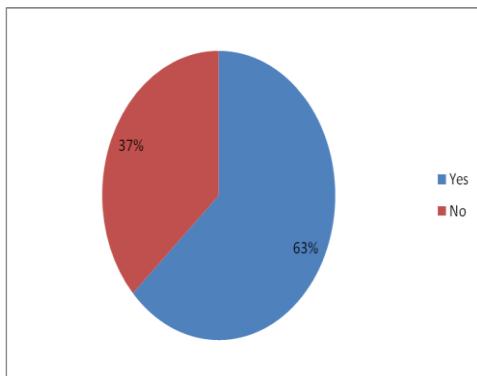


Figure 15. Individuals associated with SABRE through newsletter subscription or attendance at a SABRE event who acquired and subsequently acted upon information presented by external speakers at SABRE conferences/workshops ($n=19$).

It has been confirmed by individuals in positions of management that key information from these events has been effectively conveyed throughout the consortium and to target audiences. Furthermore the profile of relevant organisations has been heightened along with that of the SABRE project and the European Commission, as a funder and stakeholder in SABRE. The demonstration of SABRE's research and results at conferences and workshops has improved awareness and attracted interest in the project and its associated organisations from countries such as the USA. Presentations by keynote speakers at international

SABRE conferences have also provided visibility of research to a wider scientific audience

Synergy between SABRE and ongoing projects such as EADGENE has also provided a number of additional benefits through events such as the EADGENE and SABRE joint Conference (“Genomics for Animal Health”) in 2007 and the joint session at EAAP2009/4th SABRE Conference which focussed on "Molecular tools for disease resistance". A number of theatre and poster presentations took place thus encouraging extensive access to this information and further publicising both projects to a broader scientific community. EADGENE and SABRE joint post-analysis workshops have also taken place with the aim of evaluating and presenting already existing methods and software, and potentially proposing

new methods using real data sourced from within EADGENE and SABRE. Other SABRE and EADGENE workshops such as at the EAAP2008 meeting in Vilnius increased understanding of the opportunities, resources and facilities that the EADGENE and SABRE projects could offer to scientists from NMSs. Collaborations between EADGENE, SABRE and research groups located in such countries were promoted with the mutual exchange of information aiming to propel joint European research in the wider field of animal genomics.

70% of respondents acquired new contacts for their organisation through attendance at SABRE events such as conferences and workshops. These organisations were primarily members of the SABRE consortium and included Aarhus University, INRA, the University of Copenhagen, ASG Lelystad and Biosciences KTN.

5.11 The observations of overall project management – where the greatest added benefits have been gained

All board members of the SABRE consortium considered the participation of their organisation in SABRE to have promoted further involvement of other organisations within their country with European Commission research projects. 2 of the 5 board members thought this had occurred to a great extent. The strong gravitational force exerted by the SABRE project has enabled the acquisition of new projects and collaborations as its high profile presence has galvanised other activities within the field of food security due to the reputation for expertise in the coordination of research proposals that SABRE has developed.

It has been indicated by board member’s from Biosciences KTN and ASG Lelystad that an involvement with the SABRE project has provided indispensable value to their organisation. Additionally, board members from Aarhus University, INRA and the Roslin Institute/University of Edinburgh have specified that they have obtained strong value. Unexpected or additional advantages that have been gained include greater funding opportunities, an increased number of

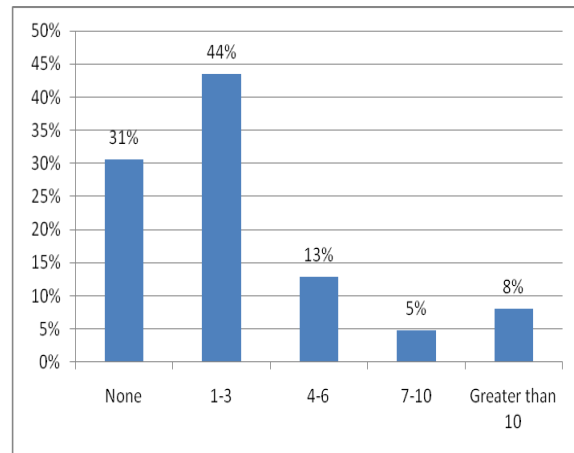


Figure 16. The number of new connections made by individuals, both within the SABRE consortium and those with an association with the SABRE project, who have attended SABRE events over the course of the project (n=62).

targets being attained, assistance in the justification of in-house investment, enhanced opportunities both new and diverse, in addition to the sustaining of existing activity. A specific example of the additional opportunities provided by an involvement in the SABRE project can be observed in the case of ASG Lelystad. A commercial MiXBLUP service was developed within WP1, which provides breeding value estimations for animal breeding programs, with its use in the SABRE project enabling the software to be promoted and disseminated amongst many new contacts that had been obtained through partnerships, collaborations and attendance at SABRE events facilitated by the project.

Furthermore, of the 77% of OMG members who indicated that new partnerships had been attained through the involvement of their organisation in SABRE, 90% have specified that new additional or independent projects and activities have also resulted.

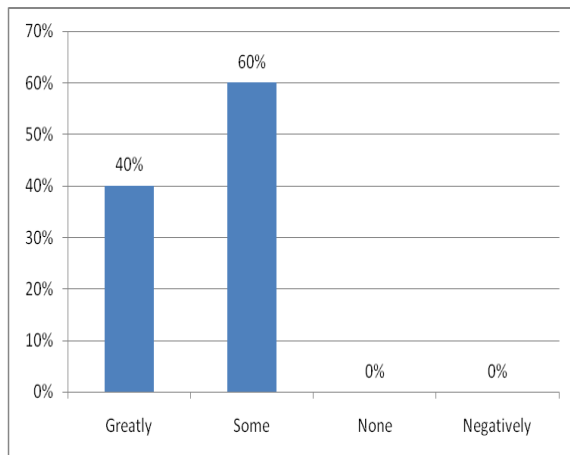


Figure 17. The degree in which the participation of board member's organisations in SABRE has promoted the further involvement of other organisations, within their country of origin, with European Commission research projects ($n=5$).

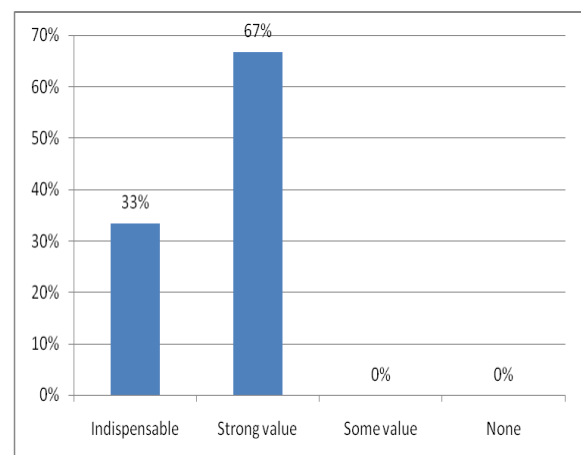


Figure 18. The degree of value that SABRE has contributed to board member's organisations ($n=6$).

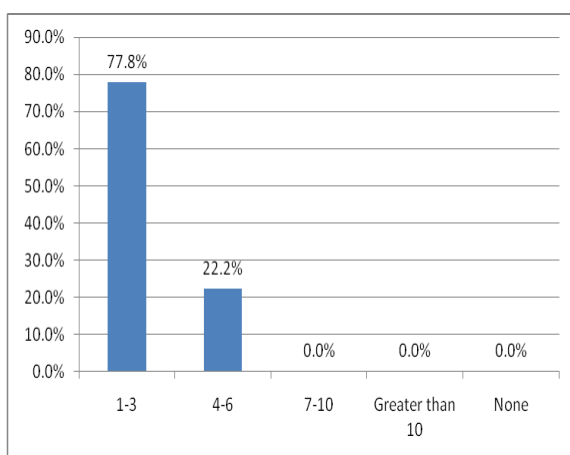


Figure 19. New partnerships that have arisen between the organisation's of OMG members and other organisations as a direct result of an involvement with SABRE ($n=13$).

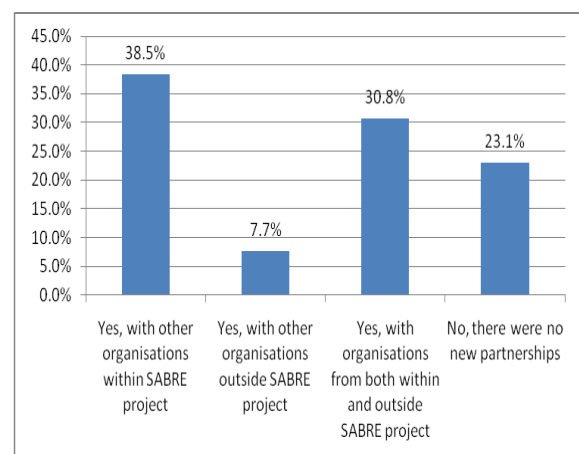


Figure 20. The number of new additional or independent projects and activities that OMG members consider to have resulted from new partnerships that have arisen due to involvement in SABRE, ($n=9$).

6. Areas of future development

The positive impact created by the SABRE project and the benefits and values achieved, many of which were additional to the original designated objectives of SABRE, can be clearly observed through the responses and information illustrated by this report. Hindsight however can always be used to provide areas of improvement or development in order to enhance future projects and experiences.

As previously highlighted, it has been suggested that international communication and cooperation both within and between WPs was limited possibly due to language barriers or cultural differences. This difficulty was underlined by certain WP leaders who described how time consuming reporting became due to the challenging nature of data collection caused by a lack of cooperation from participants within WPs. It was suggested that less reporting or more straightforward reporting may provide a solution to delayed communications however it must be appreciated that such a large project requires continual updates on WP progress, budget etc.

Another issue raised that may provide an area for development relates to the lack of continuity in management within the European Commission. It has been suggested that the policy of regularly rotating staff, such as the Finance Officer, has added to the overall cost of the project, slowed its progress and in turn possibly initiated strained relationships between partners due to misunderstandings and payment delays.

7. The legacy of SABRE: keeping the information portal open

A vital additional value that should be achieved by SABRE is to ensure the endurance of scientific knowledge that has been produced by the project and all other objectives and additional benefits that have been gained over its 4 year duration.

The scientific knowledge gained through SABRE's research presents a legacy in itself through which these research results, tools and technologies can be drawn upon to aid and enhance future projects such as Quantomics. Many of the partners within the Quantomics project were also lead participants within SABRE thus providing the scientists within Quantomics with a direct involvement, or close link through immediate colleagues, with the high quality genomics research and international research activities ascertained through SABRE. The SABRE consortium lives on beyond this single Integrated Project and the partners continue to collaborate as the Quantomics project illustrates. Thus SABRE leaves a legacy of integrated and strengthened research for the benefit of all organisations within the food security area.

In order to promote the continued existence of SABRE's achievements, with respect to scientific developments and the aforementioned additional and unexpected values and impacts, maintenance of the SABRE website could provide a portal with which to access this information. The continued dissemination of knowledge to anyone who may find value in such information will provide lasting awareness of the project and enhancement of organisations profiles and reputations. In addition, a password protected area could be sustained to enable consortium partners or SABRE associated individuals to share documents and project proposals in order to provide the continuous promotion of collaborations and partnerships.

8. To conclude

SABRE has made a vital contribution to the development of practical tools enabling breeders to improve the environmental and economic sustainability of commercial animal production, now and in years to come, through research which is advancing the genetic basis of difficult-to-measure livestock traits. SABRE's accomplishments have additionally gone above and beyond these scientific advances as numerous unexpected benefits have been gained by all organisations and individuals involved or associated with the project. The acquisition of new research opportunities, novel approaches, personal skills and new funding opportunities have provided extensive advantages and opportunities. Furthermore a significant number and diversity of partnerships and collaborations have been obtained thus establishing links which will allow further research within the food security area to be possible beyond the lifetime of SABRE. The first-rate science and hard work undertaken by all organisations across Europe and beyond has enabled SABRE to deliver full value and a great deal more throughout its project life and into the future.

APPENDIX 1

Table 1: SABRE consortium members

No.	Partner	Short Name	Country
1	Bioscience Knowledge Transfer Network	BKTN	UK
2	Institut National de la Recherche Agronomique	INRA	FR
3	ASG - Lelystad	SDLO	NL
4	University of Edinburgh	UEDIN	UK
5	University of Aarhus	AU	DK
6	Wageningen University Department of Animal Sciences	WU	NL
7	Argentix Ltd	ARG	UK
8	Cordoba University	UCO	ES
9	Parco Tecnologico Padano Srl.	PTP	IT
10	Agricultural Research Organization, The Volcani Centre	ARO	IL
11	MTT Agrifood Research Finland	MTT	FIN
12	GENUS International plc	GENUS	UK
13	Institute of Animal Genetics, Nutrition and Housing, University of Berne	UBERN	SUI
14	CNRS-UPR	CNRS	FR
15	Research Institute for the Biology of Farm Animals, FBN - Dummerdorf	FBN	D
16	Norwegian University of Life Sciences	NULS	NL
17	University of Bonn	BONN	D
18	Institut de Recerca i Tecnologia Agroalimentària	IRTA	ES
19	Lohmann Tierzucht	L TZ	D
20	University of Copenhagen	UoC	DK
21	University of Glasgow	UG	UK
22	University of Munich	UM	D
23	Cogent Breeding Ltd	CGNT	UK
24	Sanger Institute	SI	UK
25	Institute for Pig Genetics	IPG	NL
26	Biobest Laboratories Ltd	BBL	UK
27	Scottish Agricultural College	SAC	UK
28	Institute for Animal Health	IAH	UK
29	University of Medical Sciences, Poznan	AMP	PL
30	Jiang Xi Agricultural University Key Laboratory for Animal Biotechnology of Jiangxi	JAU	CH
31	Zhejiang University	ZJU	CH
32	China Agricultural University	CAU	CH
33	Universidade Federal De Vicosa	UFV	BR
34	Aviagen	AV	UK
35	Viking Genetics	VIKING	DK
36	Hendrix Genetics	HG	NL

APPENDIX 2

Table 2: Contacts requested to complete questionnaire

SABRE Participants contacted	309
Organisations	
University of Medical Sciences Poznan (AMP)	4
Argentix Ltd	3
Agricultural Research Organization, The Volcani Centre (ARO)	8
ASG - Lelystad	34
University of Aarhus (AU)	17
Aviagen (AV)	1
Biobest Laboratories Ltd	1
Bioscience Knowledge Transfer Network	9
China Agricultural University	3
Cogent Breeding Ltd (CGNT)	3
CNRS-UPR	8
GENUS International plc	9
Hendrix Genetics (HG)	1
Institute for Animal Health	3
Institut National de la Recherche Agronomique (INRA)	72
Institute for Pig Genetics (IPG)	9
Institut de Recerca i Tecnologia Agroalimentària (IRTA)	7
Jiang Xi Agricultural University Key Laboratory for Animal Biotechnology of Jiangxi (JAU)	2
Lohmann Tierzucht (LTZ)	4
MTT Agrifood Research Finland (MTT)	13
Norwegian University of Life Sciences (NULS)	7
Parco Tecnologico Padano Srl.	12
The Roslin Institute and R(D)SVS, University of Edinburgh	17
Scottish Agricultural College (SAC)	5
Sanger Institute (SI)	8
University of Glasgow (UG)	6
Institute of Animal Genetics, Nutrition and Housing, University of Berne	1
Cordoba University	15
University of Bonn (BONN)	11
University of Munich (UM)	2
University of Copenhagen (UoC)	5
Universidade Federal De Vicosa (UFV)	4
Viking Genetics	1
Zhejiang University	4
Members of European Commission contacted	7
SABRE placement participants contacted	
Country of Origin	24
Brazil	1
Bulgaria	1
China	1
Czech Republic	1
Egypt	3
Finland	3
France	1
Germany	2
India	1
Netherlands	4
Poland	3
United Kingdom	3

<u>SABRE conference attendees and newsletter subscribers (not part of SABRE consortium) contacted</u>	247
Country of Origin	
Afghanistan	1
Albania	1
Australia	3
Austria	1
Bangladesh	2
Belgium	11
Bhutan	2
Brazil	1
Bulgaria	2
Burkina Faso	1
Cameroon	1
Canada	3
Chile	1
China	4
Colombia	1
Comoros	1
Croatia	1
Cuba	2
Denmark	25
Egypt	9
Ethiopia	1
Finland	1
France	15
Germany	6
Ghana	1
Hungary	1
Iceland	1
India	1
Indonesia	2
Iran	1
Ireland	7
Italy	6
Kenya	1
Lithuania	2
Mali	1
Netherlands	38
New Zealand	3
Nigeria	2
Norway	7
Poland	1
Portugal	6
Romania	1
Sierra Leone	1
Slovakia	1
Spain	5
Sri Lanka	1

Sweden	4
Switzerland	2
Turkey	1
United Kingdom	28
United States	25
Zambia	1

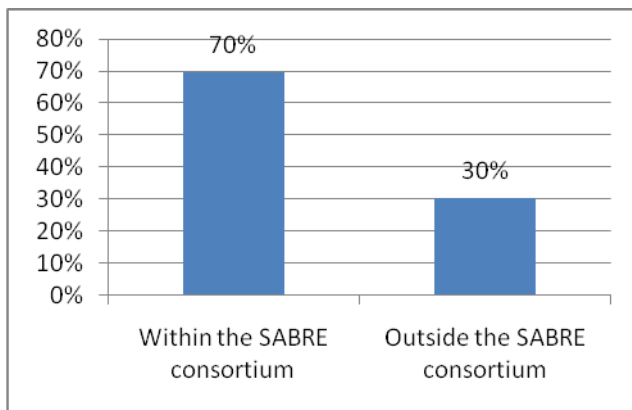
APPENDIX 3

Data gained from SABRE Impact and Added Value Questionnaire

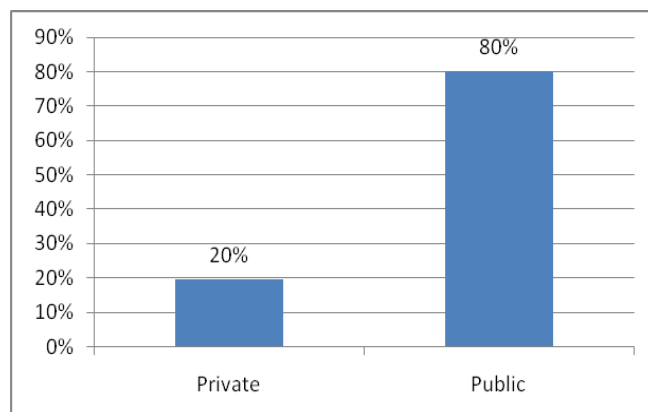
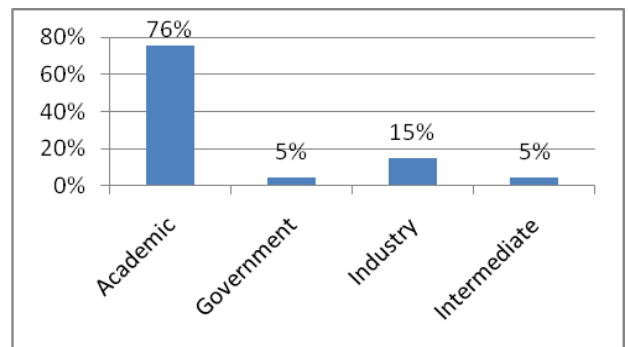
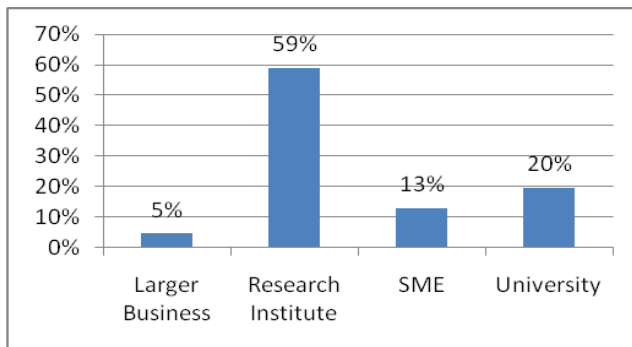
Number of questionnaires completed	136
Number of individuals interviewed in order to obtain further information	21
Average number of hits on the SABRE website per month	46483
Average number of visits to the SABRE website per month	2781

“Raw” Answers to questions asked in the survey

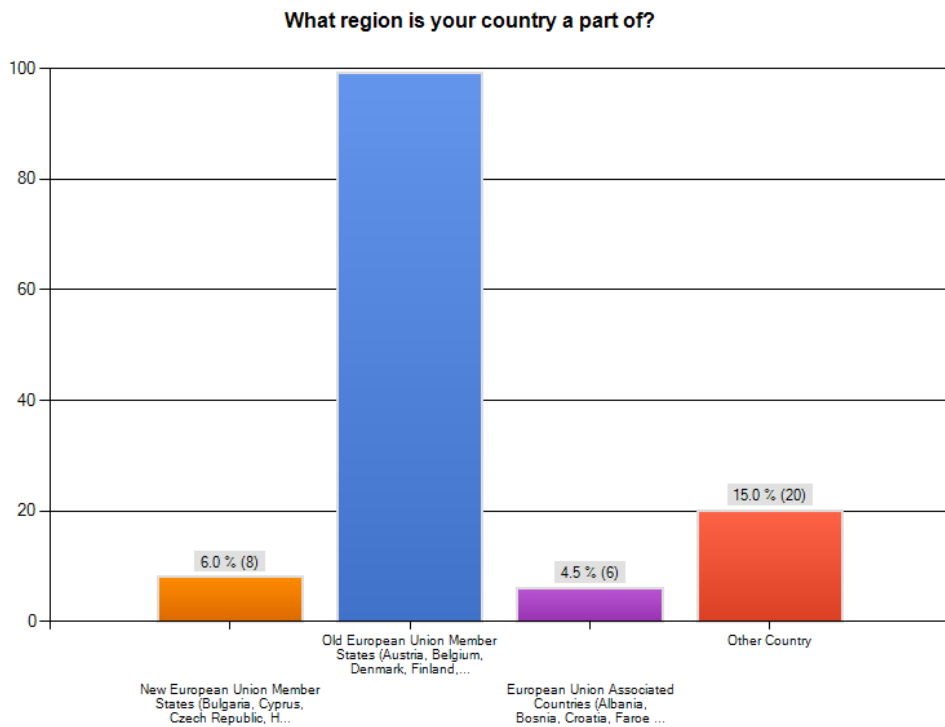
1. Is your organisation within or outside the SABRE consortium



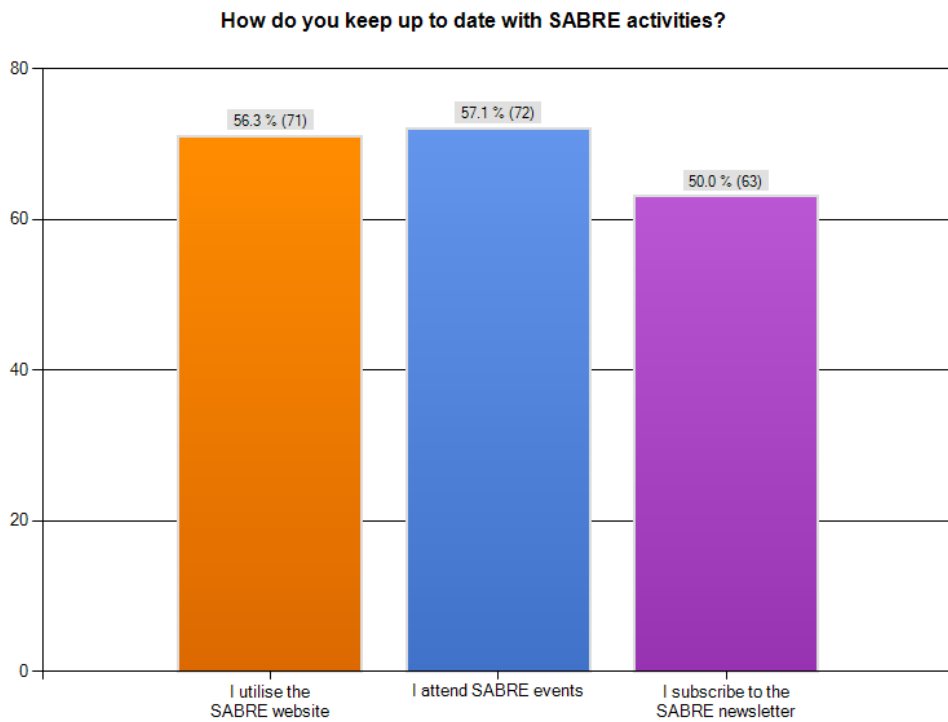
2. Type of organisation



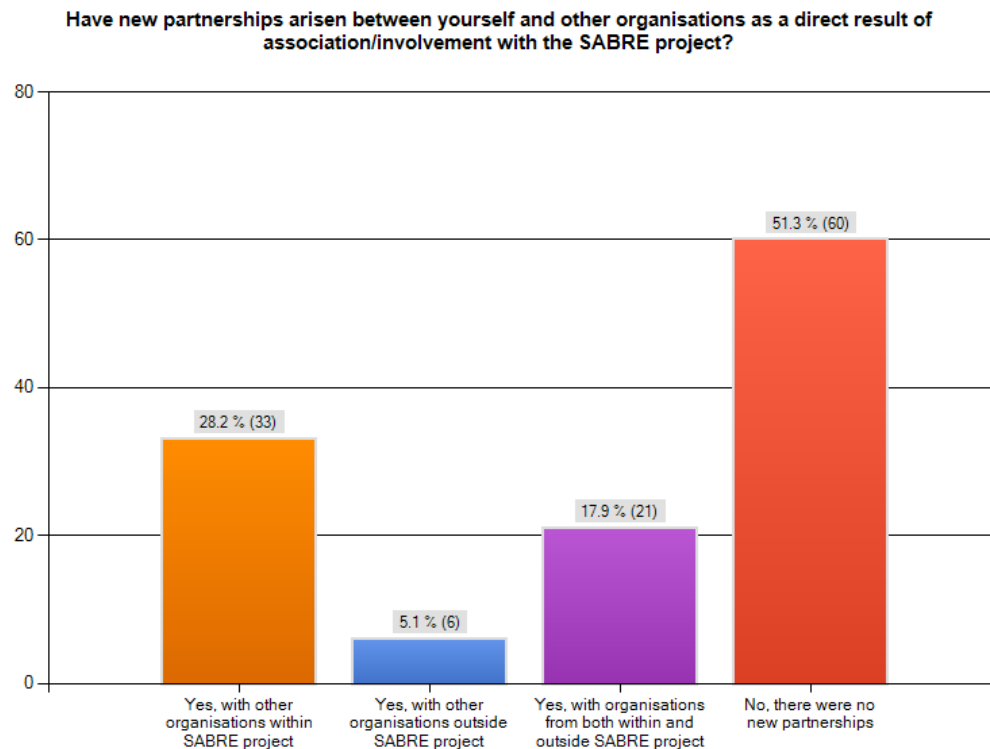
3. What region is your country a part of?



4. How do you keep up to date with SABRE activities?



5. Have new partnerships arisen between yourself and other organisations as a direct result of association/involvement with the SABRE project?

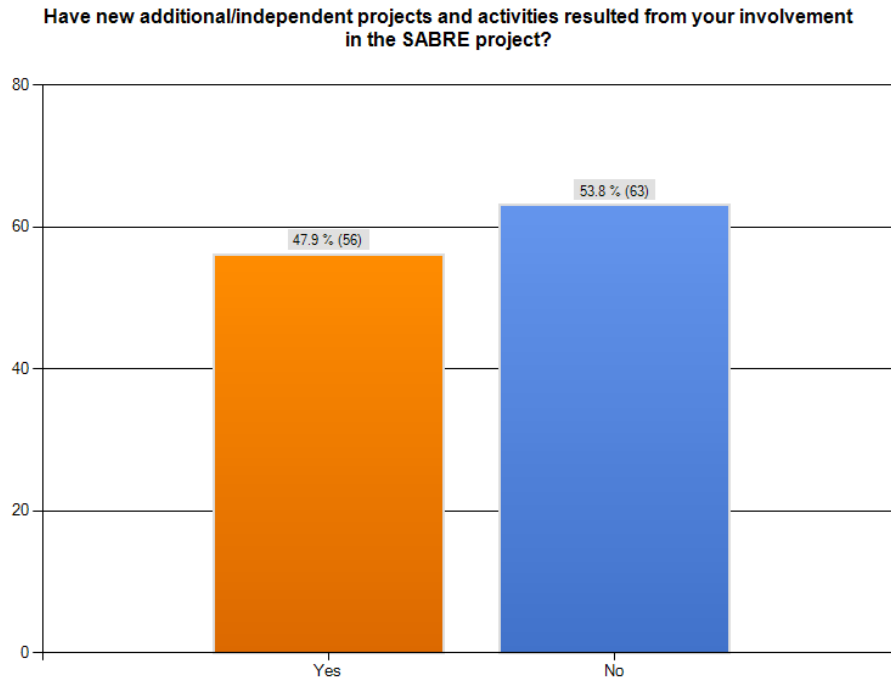


Comments

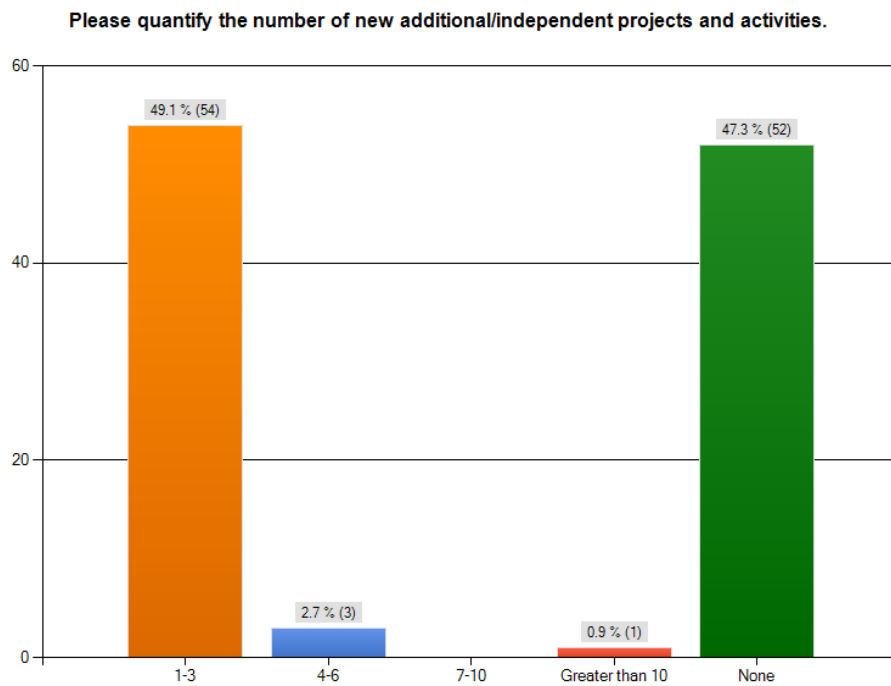
- We made a very efficient collaboration in screening epistatic QTL in a large pig F2 population.
- Application was done with new partners (EMIDA), but the project was not funded.
- The WP8 SABRE research projects have been implemented with research groups with whom I had no research collaboration, except one.
- Mainly through running joint workshop events.
- New project proposals have been written with SABRE partners, and also with organisations that are linked to SABRE partners.
- UFV and IPG.
- The Quantomics and 3SR projects are a direct result of our SABRE activity. Work over €400k new income to this business. In addition new, but unsuccessful, research applications were prepared with SABRE partners. Also some of the partners in SABRE benefitted from Marie Curie applications associated with SABRE or resulting from our experience with SABRE and Sabretrain.
- My work in institute of breeding and animal husbandry, Bonn University, Germany improved my skill to cooperate with INRA institute in France.
- I tried to make different forms of cooperation with other SABER member but unfortunately I did not receive any response from them (some of the from Denmark, Netherlands and UK) and I do not know why?
- I just subscribed to the SABRE news and didnot have any involvement as such.

- I had a 5 weeks stay at Roslin Biocentre under SABRE program. It was basically to learn new techniques in science for implementation / application back in my country of origin.

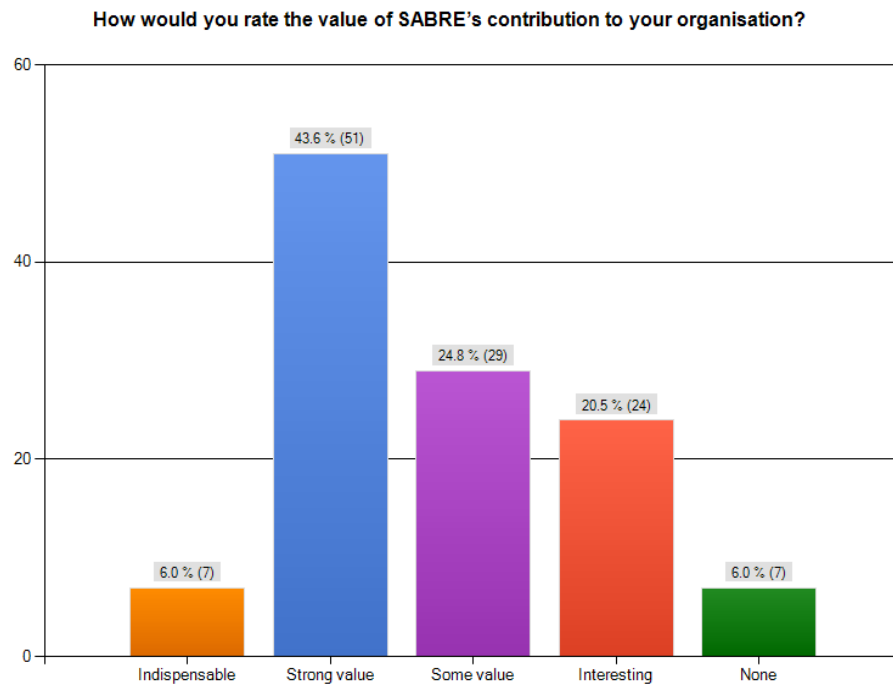
6. Have new additional/independent projects and activities resulted from your involvement in the SABRE project?



7. Please quantify the number of new additional/independent projects and activities.

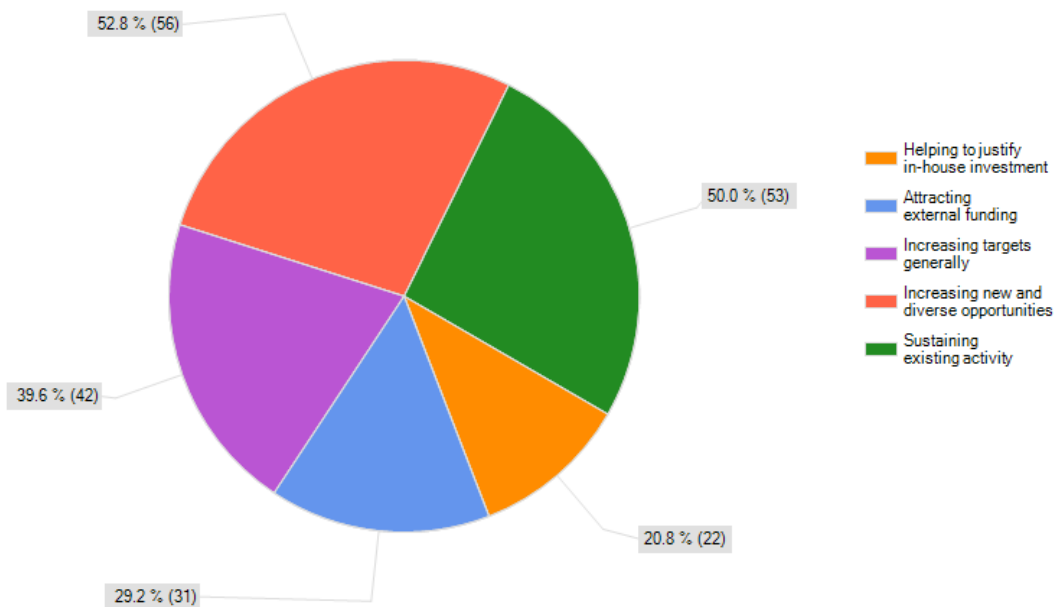


8. How would you rate the value of SABRE's contribution to your organisation?



9. What sort of value has your exposure to the SABRE project added to you and your organisation? (Please tick all that apply)

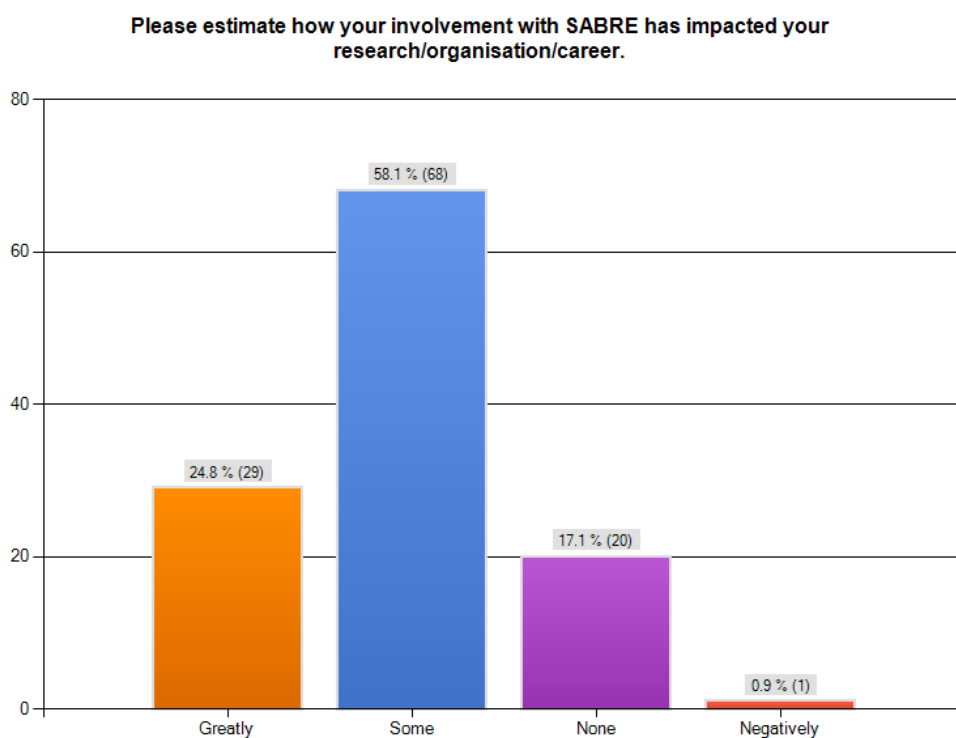
What sort of value has your exposure to the SABRE project added to you and your organisation? (Please tick all that apply)



Comments

- As a PhD student, I am not aware of the value to my organization but to me it was valuable to get ideas and make external contacts.
- The SABRE project was an opportunity to work on research projects that otherwise would not have been funded. It has also been the opportunity to use molecular tools newly developed within the project.
- I hope I can get chance to study abroad in the future through SABRE.
- Could have been more involved.
- Set up a commercial MIXblup service www.mixblup.eu
- At least, the awareness about new opportunities is being created.
- The most advantage of the SARBE project is to provide more opportunities to my organization participate the international meeting and communicate with the top foreign researcher.
- There is not a clear relationship between European projects and house support. Sometimes yes and sometimes is irrelevant.
- No involvement.
- In all cases we have benefitted from SABRE membership which we have also played a key role in ensuring is a success. The return on investment as a participant in financial terms is around 3 times and in terms of useful experience, skills development and new opportunities opened.
- the use of equipment and animal resources in framework of the SABRE project was always an important argument and priority was often given to efforts related to SABRE.
- It is not in my knowledge if SABRE project can be extended to Asian country like India so no effort was made for attracting funding through SABRE.

10. Please estimate how your involvement with SABRE has impacted your research/organisation/career.

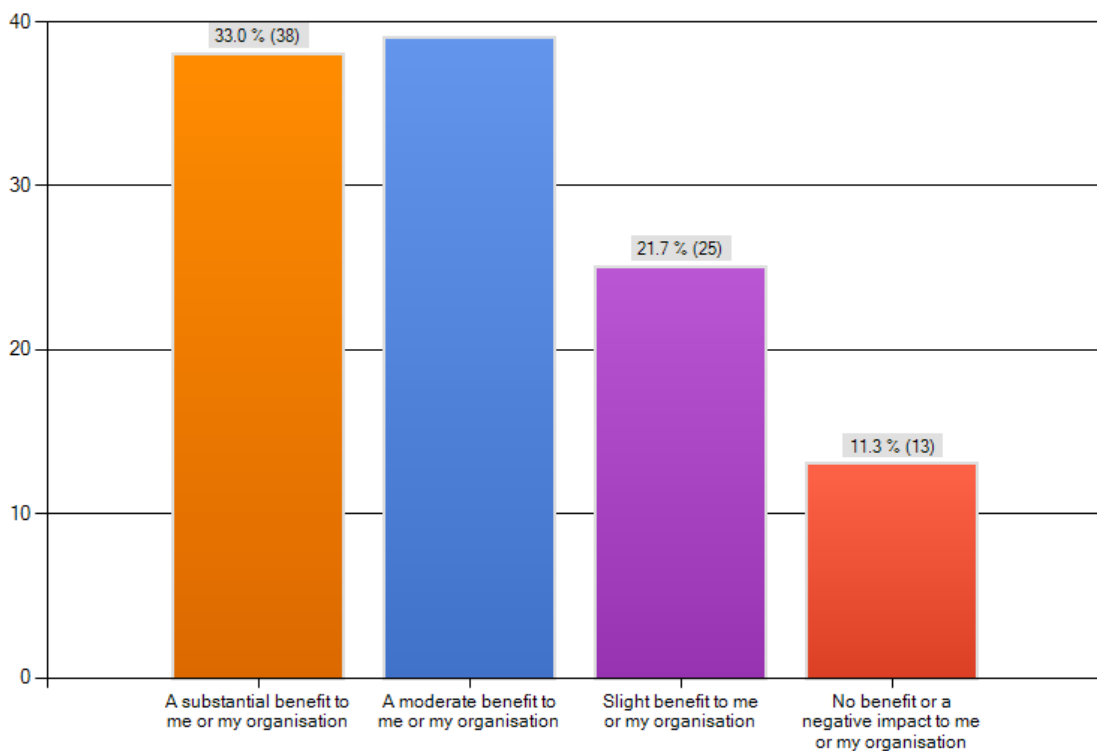


Comments

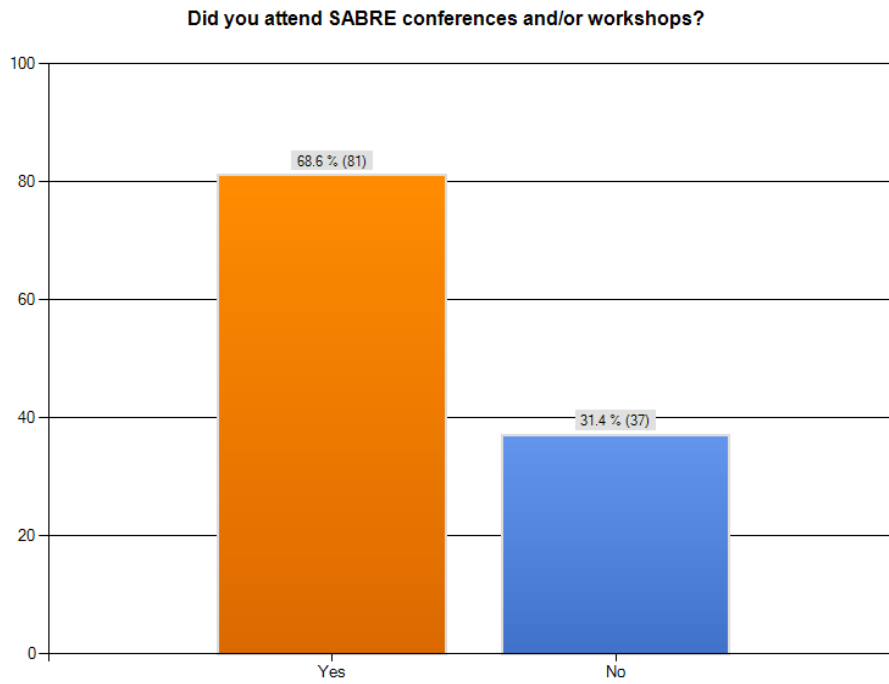
- No critical impact on my career but interesting research developments.
- Have get some useful information from SABRE.
- Allowed me increase network contacts
- Involvement with SABRE has given me a new career path and has given my organisation a high profile in Europe.
- Gave me important experience with EU projects.
- Opportunity to interact with scientists from several institutions.
- There have been new projects for my organisation.
- Improving our skill in molecular biology and bilateral exchange knowledge
- JAU don't get any research support; but it doesn't mean that SABRE project doesn't impact my organisation. First, the whole financial report in SABRE is different from it in China, we gradually learn how to deal with the related events. Second, the international meeting enhance the researcher's academic knowledge.
- I am still cooperating with Prof Schallender.
- It has many positive impacts and a few negative. Positive in terms of business and economic, negative because of on foreseen consequences of other partners behaviour.

11. Was your involvement in the SABRE project beneficial to you or your organisation's profile and reputation (in addition to that obtained from scientific publications)?

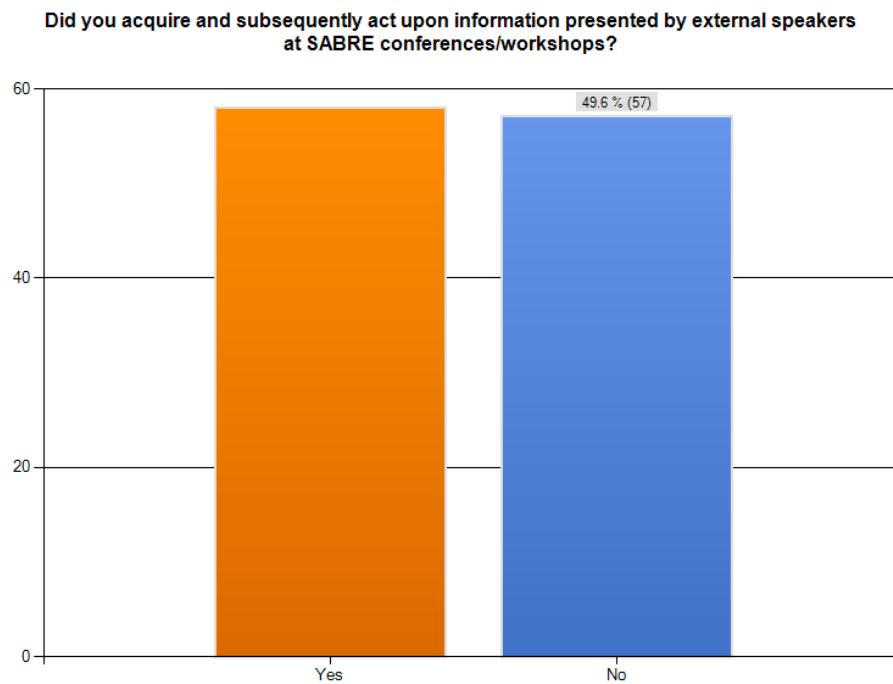
Was your involvement in the SABRE project beneficial to you or your organisation's profile and reputation (in addition to that obtained from scientific publications)?



12. Did you attend SABRE conferences and/or workshops?



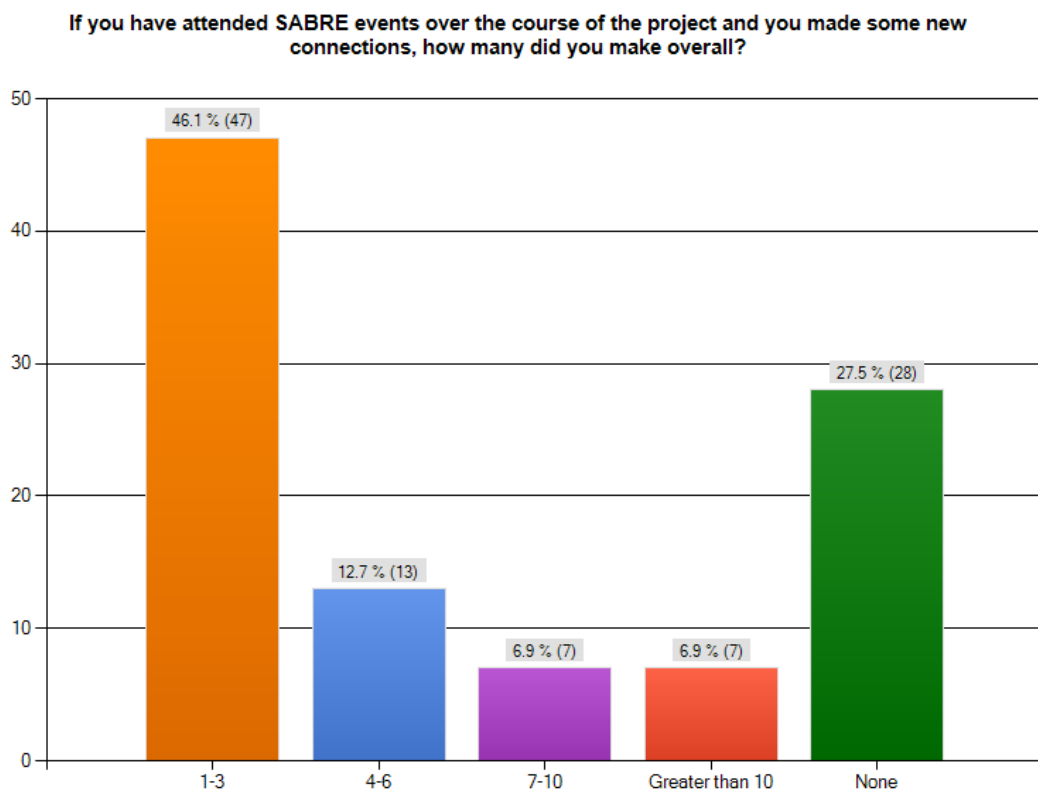
13. Did you acquire and subsequently act upon information presented by external speakers at SABRE conferences/workshops?



Comments

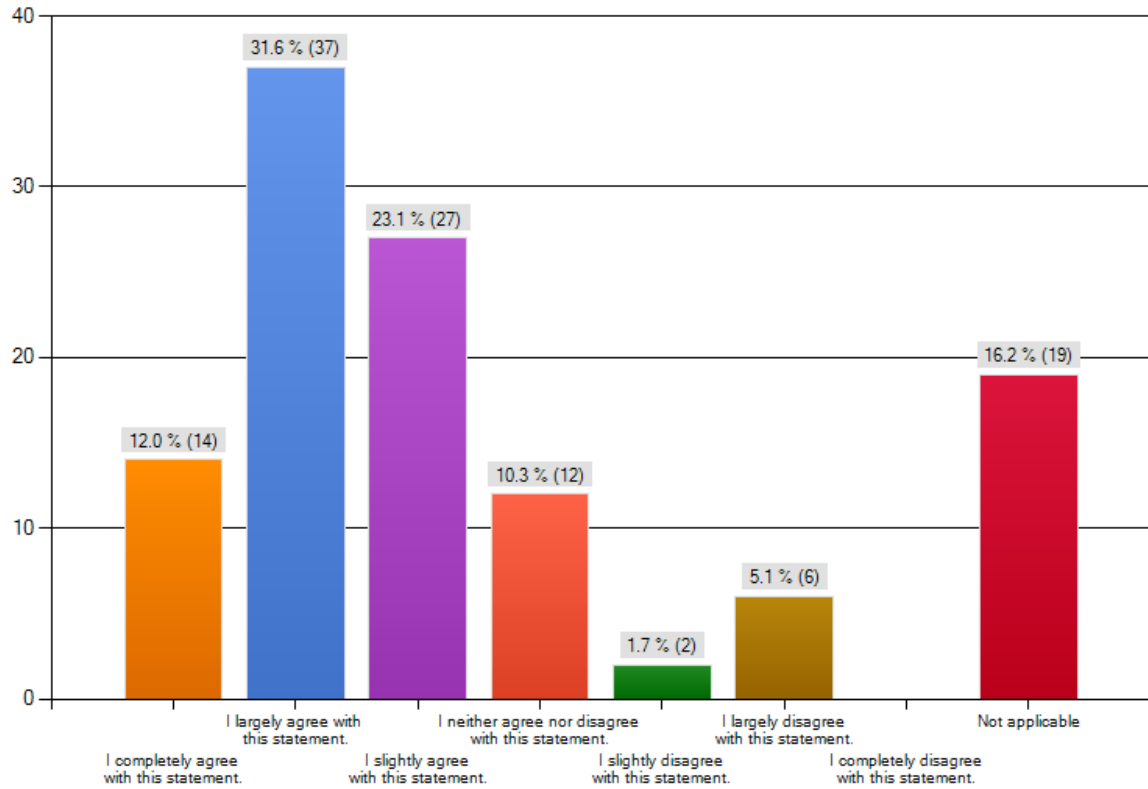
- Update my plans. Review results of others and know of upcoming opportunities.
- Information is used to relay to other organisations and to raise the profile of the organisation, the SABRE project and the EC (as funder and stakeholder).
- I hope there will be a continuous link between SABRE placement member in the future because the continuation of link is more profitable than just get some benefits then everything is finished as I see in the present time.
- This is almost the only way in which I have been able to attain information relevant to my preparation of annual reports on welfare and ethical issues in the project.

14. If you have attended SABRE events over the course of the project and you made some new connections, how many did you make overall?



15. Do you agree or disagree with this statement: 'My activities within the SABRE project benefitted from the fact that SABRE was a large and diverse research project'.

Do you agree or disagree with this statement: 'My activities within the SABRE project benefitted from the fact that SABRE was a large and diverse research project'.

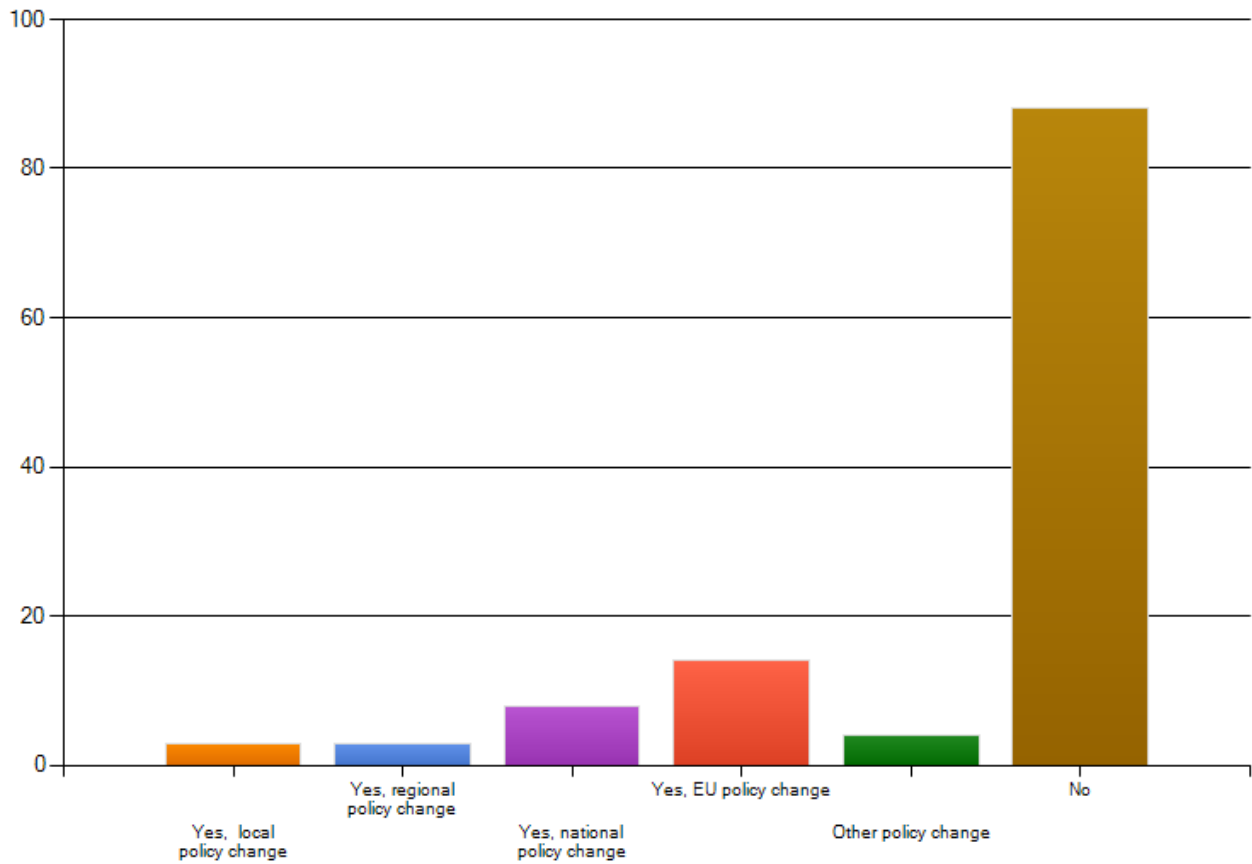


Comments

- I was not participating in the project but with the associated events.
- It is easy to lose the overview of such a large project.

16. Are you aware of any changes to policy (that have or are likely to be implicated) as a result of SABRE research? (Please tick all that apply)

Are you aware of any changes to policy (that have or are likely to be implicated) as a result of SABRE research? (Please tick all that apply)

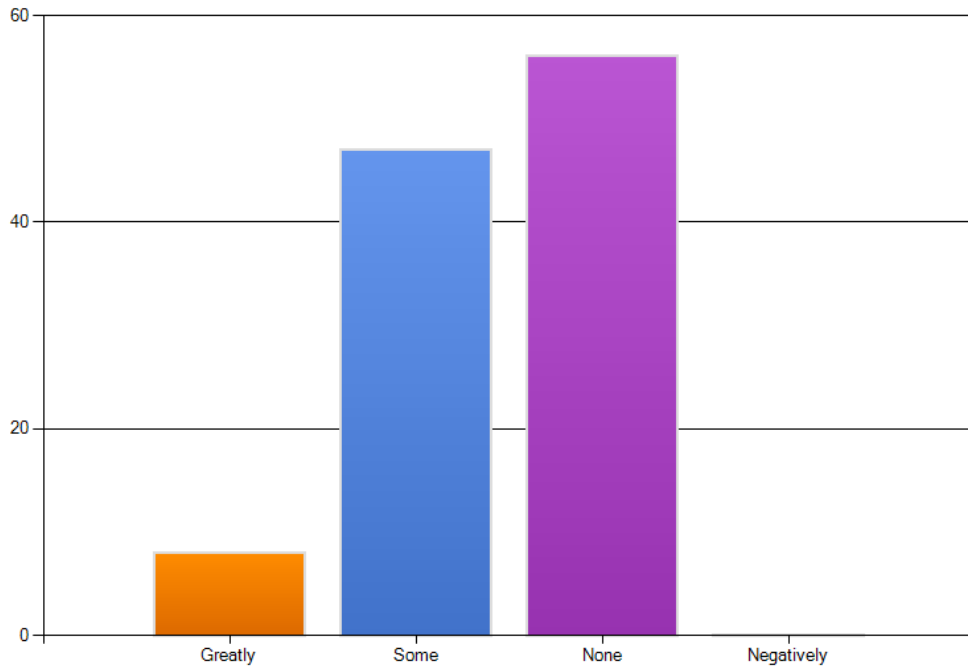


Comments

- A Hungarian Platform for Sustainable and Integrated Sheep Breeding was established by Hungarian Researchers supported by a Hungarian grant agency (NKTH).
- Much simpler rules please... let the scientists do their job - don't let them spend time filling out hundreds of forms.
- SABRE should provide new breeding strategies to improve animal health and welfare; reduce chemical and energy inputs; minimise livestock waste and pollution; and, maximise food safety and quality.
- As I mentioned before there is a gap between the placement member and the SABRE organizers.

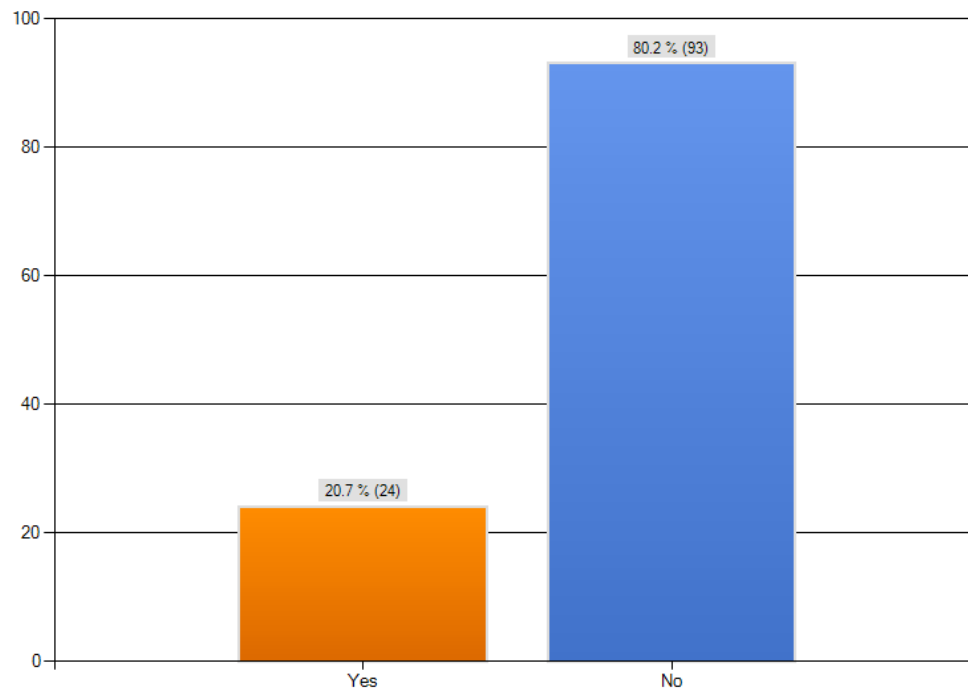
17. Did the participation of your organisation in SABRE in any way promote further involvement of other organisations within your country with European Commission research projects?

Did the participation of your organisation in SABRE in any way promote further involvement of other organisations within your country with European Commission research projects?

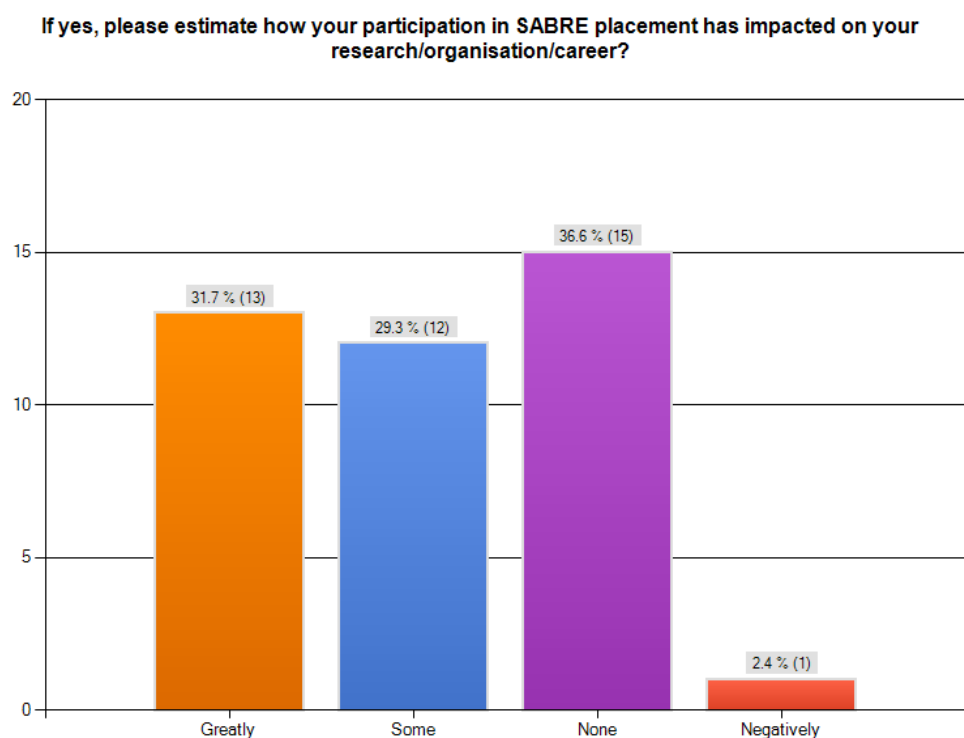


18. Did you participate in a SABRE placement?

Did you participate in a SABRE placement?



19. If yes, please estimate how your participation in SABRE placement has impacted on your research/organisation/career?



Comments

- We received a scientist from Eastern Europe. His input to our research was very weak.
- My research work in Germany through SABER placement help me to work on recent search topics microRNA in camel tissue and learned me others molecular techniques that give me a chance for further cooperation and attraction of financial support for improving animal genetics and help our country to overcome many problems.
- What I would like to say thanks to Prof Schellander to give me the opportunity to visit his institute through SABRE and to work in a new area (molecular biology) and I wish that all the SABRE member interacting like is man I see him completely different.

20. Please give examples of any additional impacts that have resulted from your experience with SABRE.

Comments

- Project collaboration opportunities at national and international scale.
- Increased queries and intake of visitors and potential collaborators.
- Exchange of ideas and methods.
- Learned a lot new techniques.
- Ideas for projects. Better understanding of some techniques used by me.

- Relationships with recognised European research institutes.
- It was particularly interesting to discuss about similar experimental approaches or studies between for different species, which is not often possible with our classical organization. Such comparative studies could be really beneficial.
- Broadened my scientific network and interactions with some were helpful.
- Experience with a BIG EU project versus a small EU project.
- I received an additional positive impact on my research and experience on animal biodiversity.
- More visibility of my research with invitations as keynote speaker in international meetings.
- Information received at events has added to the development of ideas and strategies.
- Research plans for utilization of swine genome info and SNP chip plans.
- I hope I can get chance to study abroad in the future.
- I was able to meet new contacts and informally discuss ideas.
- Have obtained important scientific results.
- Sharing of data within the SABRE project has allowed my colleagues within Roslin Institute to further development and discuss new tools.
- WP9 Boar taint continues in national project. WP1 development of MiXBLuP helps to implement MAS against boar taint. Cooperation in these areas have led to faster implementation of genomics and to better contacts with scientists in Scotland, Norway and France.
- Good network of contacts. Synergy with other ongoing project like EADGENE.
- We have implemented new technologies as a (partial) result of SABRE project funding.
- Co-research.
- Coordination of new EU project. By distributing MixBlup lot of new contacts. Industry got involved with two WP in Sabre.
- Several invitations to present the work package at workshops and conferences. Attracting interest from overseas (US).
- Engagement with and the resulting build up of trust and between my group and a major primary breeding company has established links which will allow further research possible beyond the lifetime of SABRE.
- Exposure to SNP technology and results. Exposure to the importance of copy number variation.
- Higher profile for our organisation. Strengthened our international network. Closer links with USDA.
- Other R&D Contacts in the same group of people.
- SABRE project placement allows me to build a network with Spanish scientist in my field. While my stay in Spain I attended 2 conferences which I will not be able to attend without the SABRE project scholarship.
- Continuous cooperation with Prof.Dr.Schallander and we'll publish a paper in recent topics in international journal and it helped me in improving my research work and transmit my experience to Egyptian scientists in my institute and other universities.

- Development of expertise to analyse other experiments with useful results.
- JAU can keep in touch with the international experts as a participant of SABRE.
- Participation in Welpro.
- I had learned the molecular work, and also this short visit completely changed my research carrier to a much better situation, and changed my research approaches.
- Publication of scientific papers.
- Network, contacts.
- Saw in the website some job positions/Pos Doc positions.
- Working with the European Commission has proved at times difficult because of the policy of moving staff around regularly. Lack of continuity in management has added cost, slowed progress, caused tension with partners and undermined the ultimate positive impacts/experience of SABRE to some extent.
- New contacts which I can discuss statistical issues with. Knowledge how to handle large SNP datasets.

21. **Please tick this box if you would be willing to be contacted in order to provide further detailed answers that may be used in possible case studies within the report.**

Please tick this box if you would be willing to be contacted in order to provide further detailed answers that may be used in possible case studies within the report.

