# MULTI ACTOR APPROACH IN AGRICULTURE RESEARCH

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**Abstract**

The European Green Deal and the European Bio-economy Strategy accent the need to increase efficiency of biological resources utilisation and to promote more sustainable production and consumption. Agricultural research and innovation are becoming ever more important as they can develop new technologies and innovative approaches to secure the straightforward immediate implementation. Literature recommends the multi actor approach; it is defined as a continuous communication and cooperation between research organisations and the end users. The traditional process of plant breeding (based on repeated phenotypic selection and breeding of one variety) is indeed a very long process (even 20 years). The utilisation of new progressive molecular genetic analysis can speed up this process. The aim of the paper is to discuss the economic, environmental and social benefits of the multi actor approach using the case study of a project focused on new breeding techniques, primarily molecular markers for breeding new clover and grass varieties. The case project was developed in the close cooperation of researchers and breeders.

**Key words:** multi actor approach, breeding, bio-economy

**JEL Code:** 013, 032

## Introduction

The global population is growing, incomes are rising and production is expanding which create a huge pressure on biological resources (Bracco et al., 2018) and these are utilized at the limit of carrying capacity (Egenolf and Bringezu, 2019). The year 2020 was to be a "super year" of sustainability, a year of strengthening global action to accelerate the transformations needed to achieve the 2030 agenda (Project Everyone, 2020). The European Green Deal aims to transform the EU into a fair and prosperous society with a modern, competitive and resource-efficient economy (European Commission, 2015) and it is becoming ever more discussed as a proper strategy for the post COVID-19 economic recovery. Agriculture in Europe has been affected by multiple driver and has to react accordingly (Plieninger et al., 2016), there has been and ongoing pressure to reduce the negative environmental impact and simultaneously a need to produce healthy and safe products. On 20th May 2020, The European Commission launched the Farm2Fork strategy for a sustainable agriculture and food system in Europe (European Commission, 2020). A strong focus on alternatives biotechnologies combined with precision agriculture and bio-economy is embedded in this strategy. Agricultural research and innovation are becoming ever more important as they can develop new technologies and innovative approaches to secure the straightforward immediate implementation, improvements in plant breeding have been and will be essential for providing sufficient biomass feedstock, thereby strengthening European bio-economy (Malyska and Jakobi, 2018) and the implementation of the Green Deal strategy.  Plant breeding, by its very nature, benefits from the increase in knowledge and methods that have emerged recently in the field of molecular biology, genetics and bioinformatics data analysis. The traditional process of plant breeding based on repeated phenotypic selection and breeding of one variety is indeed a very long process, it can take even 20 years. The pressure of shifting the production and reducing the negative environmental impact requires new solutions and tools that can the agriculture practice implement, therefore the new progressive molecular genetic analysis are perspective and necessary. New breeding techniques are perquisite for the sufficient amounts of sustainably produced biomass feedstock for the long-term sustainable development, food self-sufficiency and bio-economy (Malyska and Jakobi, 2018).

## 1 Reference framework

The current policy and legislation prohibit the use of genetic modification and targeted genetic editing, therefore random processes of mutagenesis and methods based on analysis of existing genetic variability remain the only available tools for breeders. The constant development of these tools can be identify as one multiple driver (Plieninger et al., 2016) as they should support breeders and agriculture practice to face challenges associated with climate change, diseases of civilization and the challenges of the circular economy, and bio-economy.

Multi actor approach (hereinafter referred as “MA approach”) brings different kinds of people together to develop the best solutions (Ingram et al., 2018). This approach yields from complementary types of knowledge (scientific, practical and other) join forces in the project activities from beginning to end that can speed up the innovation processes as the research outcomes have been assessed from several angles and the utilization and commercial success arise. MA approach can replace the linear science driven approach (hereinafter referred as “LSD approach”), where scientific knowledge are produced and comminuted to the end-users (Ingram et al., 2018). MA approach mobilizes all relevant stakeholders and make sure they are fully engaged during the whole research and development (hereinafter refereed as "R&D") phase of the project (Berthet et al., 2016), it supports feedback loops between researchers and users (Ingram et al., 2018); hereby MA approach secures the exploitation of the R&D results. The MA approach could support to align the, possibly very diverse, expectations of stakeholders (Ackermann and Eden, 2011). The comparison of the LSD and MA approaches shows the following Tab. 1.

**Tab. 1: LSD and MA approaches**

| Approach | Research input | Involvement of stakeholders particularly users | Knowledge system |
|---|---|---|---|
| LSD | Supply push from research (lab to clinic model in medicine) | At the end of the cycle or project | Users and scientists utilise different knowledge systems; transformation of new ideas from research to practices requires sufficient communication of the R&D results |
| MA | Demand pull from users (implementation science in medicine) | Direct involvement in the whole R&D project | Both users and scientists produced knowledge and innovation |

Source: Adapted by Ingram et al. (2018)

The development and utilisation of new progressive molecular genetic analysis can speed up process considerably and it is possible to obtain new materials for plant breeding with specific properties required by practice in a considerable shorter period. Literature (Berthet et al., 2016; Ingram et al., 2018; Prost et al., 2017) recommends to be implemented the MA approach in agriculture research as it secures continuous communication and cooperation between research organisations and the end users and enhance the exploitation of R&D results.

The aim of the paper is to discuss the economic, environmental and social benefits of the MA approach using the case study of a project focused on new breeding techniques, primarily molecular markers for breeding new clover and grass varieties.

## 2 Methods

The research activities are carried out using the applied theory approach and as it is based on thorough knowledge of practice (Zeithaml et al., 2020). This approach is rooted on the description of behaviour in a particular environment, explores interrelationships and connections (Zeithaml et al., 2020), and facilitate real-time observations combined interviews (Floress et al., 2018). The advantage of this approach is the active participation of researchers that corresponds to the active participation of all stakeholders in the MA approach; therefore it was selected as the appropriate method to deliver the set objective of this paper.

Red clover belongs together with alfalfa to the most cultivated and most profitable feed species, as it produces from 0.5 to 2.3 tons of protein per hectare; red clover is tolerant to rather acidic soils. However, there are currently over 230 red clover varieties available for the needs of the growers in the European Union according to the Common Catalogue. Some varieties have been included in the catalogue for decades; therefore, they cannot meet the emerging needs of agricultural practice and respond to the changing climate. There is a requirement on new methods for breeding to speed up and refine the breeding process for adaptability to stress factors while increasing the productivity and quality of forage of new varieties.

The case study of a project focuses on new breeding techniques, primarily molecular markers for breeding new clover and grass varieties. The project reflects the need of the private enterprise Hana Jakešová – Clover and Grass Breeding; Hana Jakešová is the co-author of this paper. There are four representatives of the research organisations: one main researcher, one senior researcher, one junior researcher and one technician, and two representatives of the private enterprise: one on the senior, one on the junior position. The project delivers a modern set of tools in the form of a set of molecular markers associated with selected characters of fodder varieties primarily high yield of matter more appropriate distribution (forage). The end users emphasize growth during the growing season and improved digestibility (forage) appearance, colour and leaf fineness (lawn), resistance to abiotic and biotic stress – phenotyping.

The case study consisted of the following steps:

- Project research team was acquainted with the aim of the research, project proposal, strategic research agenda and communication plan.
- Semi-structured interviews were carried out with the aim of identifying strategic goals of the project and the method for managing R&D activities; in total four interviews were provided: one with the research team leader (main researcher), one with junior researcher, both representatives of the private enterprise were interviewed; the interviews lasted approximately 30 minutes.
- Authors also observed the meetings of project team; in total authors participated on two project meetings that lasted 45, resp. 60 minutes.

## 3 Results and discussion

At first, the clover genotypes of diploid and tetraploid character were selected, the breeding material from the breeder and plants from the collection was used. Samples for DNA isolation were taken from selected plants and processed in bulk, genome libraries were prepared and the sequencing results were processed by bio informatics. Genome-wide association study (GWAS) was applied to phenotypic and genotypic data.

Our observation indicated that neither the research group, nor the representatives of the private enterprise dominated the discussions on the project meetings. The discussion was contentious because it concerned the collection of phenotypic data and development of knowledge of the additional evaluation (primarily basic measurements and morphological description). The knowledge were shared fluently among all team members, both vertically (end users – researchers and researchers – end users) and also horizontally (senior – junior and junior – senior team members). The decision process was based on collective consensual decision. The result of the project corresponds to the demand of the end user addressing the alternative environmental friendly approaches in agriculture and provides modern set of tools in the form of a set of molecular markers speed up the plant breeding for 5 up to 8 years.

In line with the main aim of this paper, the project providing was examined in the perspective of the economic, environmental and social benefits the case project brings to the stakeholders identified in the communication plan. The stakeholder typology provided by Ackermann and Eden (2011) was used.

The project brings in new tools for new materials for plant breeding that enhance breeders and allow to provide new variety in shorter time, the process can be reduced by about 8 years, save costs and also speed up the commercialisation. Hereby, farmers will be made available new variety that is more appropriate for the hotter and drought summer; the new variety can secure the production and income. Active discussion with farmers secures the acceptance of the developed new tools and breeding materials. The improved variety will be more resistant to various stress and therefore should require less fertilisers, which improves the environmental impact of the agriculture in the long term. Innovation brokers and agriculture chambers can include new techniques of molecular markers implementation to their advisory service and the newly bred variety in the portfolio of products. Agriculture chamber may support the exploitation of the project outputs to support agriculture sector. Likewise, the gene banks can enlarge their collections. The participation in the knowledge creation, sharing the knowledge and collaborative forms of problem solving are a great opportunity for project participants to acquire new knowledge and develop new skills. The scientific publications that will summarise the produced knowledge can inspire other research teams to further develop the new breeding techniques or examine other characteristics of red clover and grass. The project results hereby support innovation, creation of new knowledge that can be commercialised in the future. The Ministry of Agriculture can support other research projects focused on modern molecular markets to the strategic research agenda. The Ministry of Environment can monitor the reduction of the negative environmental impact to the nature capital (mainly soil).

The preview of benefits for the individual stakeholders group is displayed in the following Tab. 2. The findings are consistent with the findings of Ackermann and Eden (2011).

**Tab. 2: Stakeholders' benefits**

| **Stakeholder** | **Economical** | **Environmental** | **Social** |
|---|---|---|---|
| Project team members | Revenues from licence | | Skills, knowledge |
| Researchers | New ideas for projects | | |
| Breeders | | Improved variety | |
| Farmers | Higher production | Improve variety | Enhance new skills connected with new breeding techniques |
| Innovation brokers | Explanation of advisory services | | |
| Agriculture chambers | Explanation of advisory services | Environmental friendly agriculture practice | |
| Gene banks | | New item for the collection | |
| Ministry of Agriculture | Input for the strategic research agenda | | |
| Ministry of Environment | | Input for the comparative analysis of nature capital monitoring | |

Source: Authors

## Conclusion

A growing number of people around the world need a stable food base, which is a problem that has to be addressed by agriculture. Agriculture and food industry play a key role in both food supply and landscape management; the current climate change challenges and biological diseases venerability have to be addressed immediately. Agricultural systems will need to shift away from the dominant industrial agriculture paradigm designed for production, self-sufficiency, efficiency and affordability to one of sustainable agriculture that conserves land, water, and genetic resources, and is environmentally appropriate, economically viable and socially acceptable.

In the last decade, whole genome genotyping methods have been developed there is no need to track one or more genes out of tens of thousands, conventional methods of selection according to the phenotype can be extended by selection for genetic markers associated with agronomically significant features. Methods whole genome genotyping to be more accurate and the breeding process can be improved while close cooperation of researchers and end users is vital for the application and acceptance; in comparison to the conventional breeding, the total period required for breeding of at new variety can be significantly reduced with higher quality of the result. The time factor is becoming ever more important given the current climate change or unpredictable global development. MA approach is a way, how to use science in the co-creation of a more sustainable world and agriculture as it brings economic, environmental and social benefits to the stakeholders who are involved in the whole project lifetime.

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