The continuous evolution of the Bazancourt–Pomacle site rooted in the commitment and vision of pioneering farmers. When reality shapes the biorefinery concept

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EFB Bioeconomy Journal 1 (2021) 100007

Contents lists available at ScienceDirect

EFB Bioeconomy Journal

journal homepage: www.elsevier.com/locate/bioeco

The continuous evolution of the Bazancourt–Pomacle site rooted in the commitment and vision of pioneering farmers. When reality shapes the biorefinery concept ☆

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ARTICLE INFO

Keywords:
Bioeconomy
Biorefinery
Agricultural cooperation
Industrial biotechnologies
Green chemistry
Industrial symbiosis

ABSTRACT

Agriculture in Champagne owes its development to the determination of people and their ability to implement technical progress, work together to adapt to changes. The strong dynamic of the agricultural cooperative has been crucial in this exceptional development, in terms of agriculture, industrial processing and innovation. The Bazancourt–Pomacle biorefinery is both the result and the symbol of the determination of local farmers to develop new regional outlets by using cutting-edge technologies. The success of the site, considered as "the archetype of a territorial biorefinery," is a perfect illustration of how, through innovation, weaknesses can become strengths. For this constantly evolving model, 2021 is, with the growing importance of bioeconomy, a new tipping point for the Bazancourt–Pomacle biorefinery.

Introduction

Hunger, climate change, energy shortage are simultaneous challenges that we are facing. Bioeconomy seems to be a potential and global solution. Based on biorefineries it is not just a theoretical concept as demonstrated in Bazancourt–Pomacle site (Stadler and Chauvet, 2018) Fig. 1. This biorefinery is one of the best-known in Europe. It illustrates what is often still considered as a concept. Located near Reims (France), this site hosts an innovation platform at the heart of an agro-industrial cluster (concept considered as defined by Porter, 2000). It is recognized as an integrated biorefinery, a model of industrial ecology and rural bioeconomy. It manufactures food and feed ingredients, fuel and chemicals. It highlights the potential of the industrial bioeconomy to replace fossil fuel (coal, oil and natural gas) from more sustainable and renewable resources (mainly agro-resources, biomass). Recently, this platform has been labeled "territory of industry".[1]

This site is the result of 70 years of continuing initiatives (Chauvet et al., 2013). Its particularity relies on the combination of diverse industrial facilities and a development based on innovation and a knowledge-based operation.

Schieb et al. (2015) shows that the initiation of such an ecosystem is not easy to plan, but at the same time, it is not a question of a mere chance. High levels of alignment between the actors and in the circumstances are part of the explanation of this development such as consistent support of the farmers and of their two cooperatives, accompanied

[1] Launched by the Prime Minister at the National Industry Council on November, 22nd 2018, the National Industry Territories Program is a strategy for industrial reclamation by the territories.

Abbreviations: 2G, second Generation ethanol; ADM, Archer Daniels Midland; ADRIAC, association for the development of research in the agro-food and packaging industries; ARD, agro-industry research and development; ARDEVAL, association for the valuation of cereal by-products; BRI, biorefinery research and innovation; CAVISA, center for analysis and industrial valuation of agricultural substrates; CEBB, European center for biotechnology and bioeconomy; CAP, common agricultural policy; CHP, combined heat and power; CO_2, Carbon Dioxide; CRD, cereals research and development; DHA, dihydroxyacetone; DSP, down stream processing; ERD, ethanol research and development; IAR, industry and agro-resources; INRae, National Research Institute for agriculture, food and the environment; NMR, nuclear magnetic resonance; *R&D*, research and development; SRD, sugar research and development; TRL, technology readiness level; WWII, second world war.

☆ This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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https://doi.org/10.1016/j.bioeco.2021.100007
Received 3 April 2021; Received in revised form 20 May 2021; Accepted 27 May 2021

Fig. 1. Overview of the site.

by the local authorities since the 1990s and favourable market conditions.

This work will present, through several examples, that the informal guideline of this perpetual and steady evolution is the great capacity for adaptation of a sector in an evolving environment and its ability to reinvent itself to overcome weaknesses through innovation.

1 *Technological innovation to allow a deep transformation of a disadvantaged territory and to rise a performant agriculture among the best in Europe*

Champagne-Ardenne area was originally a disadvantaged agricultural region because of its poor geological features (chalky land). Diderot and d'Alembert described it, in their 1753 Encyclopaedia, with the expression "Champagne pouilleuse" or "Flea-ridden Champagne" (Garnotel, 1985).

Starting in 1950 and over the next twenty years, to fight this reputation, the clearing of nearly 115,000 hectares took place. This action allowed large additional areas of arable land concentrated in large farms. The acquisition of motorized equipment as tractors and the use of mineral fertilisers made it possible to cultivate the chalky lands of Champagne. The cleared land was quickly planted with rapeseed, cereals and then sugar beet.

Thanks to their constant search for innovative solutions and their ability to put technological advances into practice, the farmers of Champagne had succeeded. By the middle of the 1960s, Champagne was finally equipped with an intensive well-structured production system, identical to those in the great arable region of the Paris basin that had always been fertile. These transformations resulted in a 500% increase in the profitability of its farms.

The coordination of these initiatives and others was permitted by various powerful local mutual organizations with charismatic leaders.

2 *Organizational innovation: setting up of cooperatives to serve collective development*

The agricultural cooperative movement is deeply rooted in the Champagne region around Reims. Actually, before getting the legal status of cooperatives, the farmers initiated a dynamic of cooperation through local agricultural trade unions. Locally, the impetus was given by an entrepreneur of the textile industry, Léon Harmel, well known for his influence for the social encyclical of Pope Leo XIII "Rerum novarum".

Quickly, in order to develop a common purchasing and selling activity, it became mandatory, by law, to separate trade and union activities (Curutchet, 1999).

In this first period, a farmer, encouraged by Léon Harmel himself, played an important role: his name, Gustave de Bohan, still cited today for having said "Let's do our business ourselves" what means to do for undertaking and us for all together. In 1927, Gustave de Bohan set up the Providence Agricole cooperative, simply as an extension of the Champagne Farmers' Union. During the crisis of the 1930s, this organization helped the farmers to get better conditions and guarantees to access to a healthier and more profitable market.

After WWII, the country, as well as Europe, faced starvation and food restriction. In the context of the nascent CAP, the farmers of this region continued their cooperative dynamic by adopting modern practices such as building silos. One spoke about "champagne miracle" (Garnotel, 1985) and, as recalled above, the farmers have succeeded in transforming a poor land into productive fields among the best in Europe. Progressively the smallest cooperatives merged with others to form larger cooperatives and the more famous was Champagne Céréales set up by … Jacques de Bohan, Gustave's great-grandson.

This first inter-cooperative partnership was the starting point for an unstoppable movement towards pooling and the awareness that joint action was the only way to continue to exist, to develop and to remain competitive.

Vecten et al. (2012) says: "We always fought to make farmers understand that it was in their interest to remain united and we were right: look at the progress achieved in research thanks to the involvement of the cooperative movement; if we had allowed them to stagnate, it would have been a major strategic error."

Today, the Champagne region is considered extremely advanced, thanks to the determination of men and their ability to work together to adapt to changes in the environment (Filippi et al., 2008). Currently, the Bazancourt–Pomacle site employs nearly 1200 people and is responsible for 800 indirect jobs. It operates 24/7 converting 4 million tons of different types of biomass (mainly sugar beet and wheat, but also alfalfa and more recently woody materials) on a site of more than 260 hectares.

Two world-scale agro-industrial cooperative groups are closely involved in the making of the site: Vivescia (with one of its roots Champagne Céréales) and Cristal Union. Over time, their involvement has enabled nearly a billion euros of investment to be mobilized, and gives the site industrial dynamism, with more than 20 millions euros invested annually.

3 *Territorial innovation: from a sugar factory to an integrated biorefinery based on industrial metabolism*

Without any master plan, the site has evolved to become an integrated biorefinery combining an industrial cluster (or pole) and an innovation cluster (Chauvet, 2018, 2019). Actually, as it has been already described, such a dynamic of co-location of entities reveals a potential to mutualize some activities (Maskell, 2001) to form an industrial ecosystem (Chertow, 2004), supplying each other with intermediate products, energy and services (Erkman, 2004). The economies of scale or diversification made possible by this geographical proximity of the different players are key factors for competitiveness. Thus, the biorefinery can optimize its procurement and production depending on the markets upstream and downstream of its activities. This economic optimization can be accompanied by environmental optimization, when it includes reductions in waste, energy consumption and other inputs (Junqua and Brullot, 2015; Brullot and Buclet, 2011).

Already at the beginning of the 1990s, with the creation of the shared *R&D* firm, ARD stemming from sugarbeet and cereals coops, as well as the establishment of the starch factory so-called Chamtor (now ADM

Bazancourt), industrial ecology has emerged as a key characteristic element of the biorefinery.

Between 1992 and 2005 the sugar beet factory and Chamtor established the first synergies in particular by sharing steam and for spreading effluents and in the same time, ARD launched its first subsidiary Soliance in 1994 (which will be sold 20 years later to Givaudan).

2005 was the year where president Chirac launched the dynamic of the competitiveness clusters in France from the site of ARD. As of that moment, the site has transformed dramatically with several new facilities, pilot and demonstration plants: Cristanol producing bioethanol from wheat and sugar beet co-products, the Air Liquide workshop for the recovery and processing of fermentation-issued CO_2, the pilot of the Futurol Project a world class initiative for developing bioethanol 2G (now owned by ARD), the BioDemonstration plant (also owned by ARD), for the scale up of bioprocesses up to TRL 9, and Wheatoleo (a subsidiary of ARD) producing surfactants. In 2009, the French ministry in charge of the industry classified the site as the first open innovation platform so-called BRI (Stadler and Chauvet, 2018).

Even if all the components of this "cluster" remain independent, in their management and their shareholdings, they are more or less in mutual connection with different types of flows and they function like a living organism. Some observers have compared this site with the world famous Kalundborg port in Denmark. This example, recognized as the birthplace of the circular economy concept, is often cited for the implementation of the principles of industrial ecology thanks to the density of exchanges organized between local economic actors. Nowadays eight types of synergies have progressively been developed: water, steam sharing, effluent management, products and coproducts, *R&D*, energy, organization, and drilling. From an environmental perspective, optimization of water and energy consumptions are two main indicators particularly monitored in order to limit the environmental footprint.

The last settlements have been, for the innovation platform, the CEBB and for the industrial part, the arrival of Européenne de Biomasse that just commissioned its first unit for producing, from wood, "black pellets" and steam with part of it supplied to ADM.

This development of synergies is on-going in the sense that processes are constantly being improved (Lombardi and Laybourn, 2012; Diemer, 2015), the use of by-products is being developed and increasing savings in resources are always on the agenda. The desire to consider the plant as a whole, to minimize its harmful aspects and environmental footprint, to return to farmers the organic elements they need, is a daily concern of all the biorefinery actors (Bouteiller et al., 2018; Thénot and Lescieux-Katir, 2016, 2017, 2018; Thénot et al., 2018).

This site, by constantly optimizing its flows, was a precursor of modern biorefineries, concretely organizing itself as such even before the emergence of the concept. Maybe this is what we call in French "le bon sens paysan" (i.e., "farmer's common sense").

Research has been the best way to find innovative solutions and to foster this dynamic. The development of the Bazancourt–Pomacle platform is closely linked to the growth of research. Research really began to develop by the end of the 1980s, when overproduction provided the opportunity to offer farmers new non-food outlets for their production.

The factors were therefore in place to encourage farmers and their leaders to begin to consider crops differently and launch new industrial ventures.

4 *Cross-sector innovation: towards collaborative research to regulate the overproduction*

Let's go back to 1990s and the origin of the local impetus. After having set up an efficient agriculture, after having built factories all over the region (malting units, dehydration units for alfalfa) farmers had to deal with surpluses at European level in the 1990s – which triggered a strong CAP reform – with warning signs as of the 1980s. They decided behind their local leaders to commit themselves in the search of new outlets for their production. As described in Schieb et al. (2015), the first joint initiative between research and agro-industry was launched in February 1983 by Jacques de Bohan. It consisted in the launch of the ADRIAC, specialising in packaging science and techniques, to provide the food industry with new outlets through the development of bio-based and biodegradable packaging for meat products.

Then began the long and successful story of ARD, which is now well-known beyond national borders. In 1989, ARD was founded on solid ground made up of the progressive merge of three structures devoted to plant-based research: SRD, ERD and CRD (See Fig. 2). From ARD, two daughter companies have been created as already mentioned: Soliance recently acquired by Givaudan Active Beauty and Wheatoleo still in the premises of ARD.

ARD's core business since its creation has been helping companies with scaling up innovative bioprocesses. Thanks to the expertise of its teams and diverse dedicated equipment, ARD can accompany countless start-ups and companies with the scale up of their proof-of-concepts validated at from the laboratory scale to commercial-scale production.

Since its creation, ARD has established several areas of expertise in adding value to crops:

- Industrial biotechnology: The production of new compounds or products (plant health products, cosmetics, food industry, etc.) from plants and microorganisms is now possible thanks to the development of biotechnology. From the identification of a strain of bacteria to large-scale fermentation (Biodemo) and the pilot plant in between, ARD has all the facilities required for the large-scale purification and production of bio-based molecules (biopolymers, succinic acid, DHA, etc.). This cutting-edge equipment can also enable companies to speed up their products time to market.
- Bioinputs: Solutions for excellence in farming: Screening, development, formulation of microorganisms, field trials, and industrial scale-up of production.
- Plant extraction: Over time, this age-old practice has become more complex and technology-intense, requiring specific cutting-edge equipment to extract the desired active ingredients from plants. From the production of substrates to the isolation of natural substances, processing fermentation (DSP) and biorefining, ARD teams have in-depth knowledge of all the processes needed to produce valuable molecules at different scales.
- Green chemistry: Closely related to white biotechnology, green chemistry and plant-based chemistry can be used to produce synthetic molecules from a biodegradable and renewable source: plants. Its aim is to replace many fossil fuel-based molecules by new compounds in cosmetics, agro-industry (bioplastics), civil engineering, and surfactants with the production of alternative solvents.

After 10 years of opening up to external customers, of providing services to world-class start-ups such as Amyris, Global Bioenergies, Fermentalg, and global players such as Corbion, ARD confirms a new strategic model by becoming gradually a tailored-made developer and manufacturer.

5 *Going further with the involvement of academic research to shape the future and draw up long-term strategies*

Alongside private research, public research is also organized locally to meet the challenges of its territory. After a few failed attempts of adapting fundamental and applied research to develop innovative uses for agro-resources locally, "Agropole Européen,"[2] is created in 1991 in Reims. It gathers the University of Reims Chemical Physics and Biotechnology Research Center, ARD and the INRAe Chalky-land Agronomics Research Center.

In 2005, based on all these existing partnerships combining academic research, applied research and industry competences, the Champagne-Ardenne region decided to team up with the Picardy region to create

[2] Renamed Europol'Agro in 1994.

The birth and the timeline of the innovation platform within de biorefinery: a long journey

- 1983 to 1987 SRD followed by ERD: when sugarbeet growers interests meet those of the cereals growers for finding out new outlets

- 1988 to 1990 creation of CAVISA in Reims: an interface between academia and agro-enterprises, first initiative of collaborative approach,

- 1989 to 1990 the origins of ARD beyond ERD and its setting up near the sugar factory of Bazancourt

- 1991 simultaneous launching of Europol Agro and Fondation Paris Reims with the support of local authorities: the common vision of the creation of ISTV with national ambitions

- 1992 to 1997 ARDEVAL followed by CRD: association of the regional cereal cooperatives for pooling the research endeavour and to join ARD as shareholders

- 2005 to 2009 from IAR to BRI: in the context of the IAR cluster, BRI was created under the impetus of ARD which was committed to allow its opening to external partners with the perspective of the creation of CEBB

Fig. 2. How research was created and evolved on site.

the IAR Cluster to revitalise the economic tissue of regions on the plant-based biorefinery sector. The IAR cluster helped to attract major engineering schools, as the Bazancourt–Pomacle site presented excellent possibilities for academic study and experimentation.

The project was a success and was strengthened in 2012 with the significant financial support by the local authorities which have enabled the launch of the CEBB.

The CEBB is a multidisciplinary research academic center, with a technological hall and a chemistry scale-up zone at the heart of the biorefinery, whom mission is to enhance the value of biomass and industrial by-products. It brings together the complementary scientific and technical expertise of about 60 researchers from AgroParisTech, CentraleSupélec, NEOMA Business School and the University of Reims Champagne-Ardenne, and covers the entire knowledge and competencies needed to foster innovation and new technologies: white biotechnologies, green chemistry, process engineering, multi-scale modeling and studies of promising market tracks. Moreover, the proximity to industries allows CEBB researchers to, not only identify and answer the technological locks industries encounter, but also to develop the research projects that will feed the research and teaching activities offered to students.

The CEBB not only relies on the human and technical skills but also on the facilities needed to scale-up the proof-of-concepts (TRL 3) validated at the bench scale at the (semi-)pilot scale (TRL 4-5). It covers the development of products from the mL scale (vials, microplates, microreactors) to the scale of ten or even hundreds of liters (e.g. fermenters, photo-bioreactors, pre-industrial separation pilots).

To support its teams and research projects, the CEBB has developed a complete shared analytical platform that allows the characterization of the biomass as well as the (bio)molecules and the (bio)materials of interest developed in-house. This platform of excellence covers the fields of NMR, liquid chromatography, gas chromatography, thermal analysis, confocal microscopy and imaging.

This original model contributes to foster innovation, breed ground for new business opportunities and envisaging long-term strategies by (i) creating original knowledge in the forms of scientific publications, patents, methods, implicit knowledge which will permit long term innovation pool; (ii) training in research (through research) for strategic competencies and professions needed for the development of the bioeconomy for years to come; (iii) facilitating economic development (e.g. company creation, in-kind contributions to industrial projects, attract start-ups); (iv) linking a scientific community with an industrial site in such a way that genuine synergies occur.

6 *A turning point or a tipping point: What next? Towards a formal governance to ensure the development of companies already in place and to welcome new ones*

Until recently, the development of the biorefinery has been achieved by “endogenic” development, i.e. development carried out by the cooperatives themselves on agricultural land. As already mentioned, the launch of the cluster IAR (Industries and Agroresources) in 2005 marked an important milestone with the setting up of an important world-class project (i.e. Futurol project for second generation biofuels) and an outstanding facility (Biodemo by ARD). The role of the local authorities in the creation of the CEBB with European ambitions has already been mentioned and more recently the sale of Soliance and Chamtor to Givaudan Active Beauty and ADM, respectively, has brought new international stakeholders. The last major investment was made by Européenne de Biomasse with the establishment of a CHP co-located with a “black pellets” plant. These movements have not only considerably shaped the landscape of this biorefinery, but also deeply induced a “game changing” in terms of interactions between the stakeholders.

Furthermore, the Grand Est Region details, in its bioeconomy strategy, the framework of actions to be carried out in the years to come, to improve the share of biobased products in economic activities in the region. This bioeconomy strategy is part of national and European policies. The development of the bioeconomy and the deployment of specific support policies will generate even more competition between (i) regional actors for obtaining subsidies, and (ii) territories for attractiveness. No doubt that the example of this local biorefinery inspires the strategy of the region. In return, the latter will provide a leverage effect to access to European initiatives, such as the “Circular Bioeconomy Europe”, succeeding to BBI. Its support, particularly financial, conditions future developments.

Numerous challenges are ahead for the biorefinery (See Fig. 3). There is therefore an urgent need to be organized more formally to stay in the race.

The setting up of a more formal governance of the site became essential. With an association bringing together industries, academia and local authorities in connection with immediate neighbourhood the future is opening up on new basis. This new organization is taking place in the frame of the Territory of Industry initiative which is supported as a priority for the re-industrialization in France. Fifteen years after the Competitiveness Clusters, this initiative aims to give a new impetus and opportunities for a “growth driver”.

The Bazancourt–Pomacle story is still in motion and this new step will offer the new means for future and sustainable developments. It will allow also to overcome the limits we have been facing due to an “unplanned” development. However, the driver remains the ability to gather people and combining vision and resources to make the necessary investments. It is time to further structure this industrial ecosystem, but, probably, the story would not have started without the vision and the spirit of the pioneers.

The issue of the repeatability and duplicability of such a “model” is not obvious. It depends of many factors and parameters, such as lo-

STRENGTHS	WEAKNESSES
- A recognized site (Territoire d'industrie, members of the IAR cluster) - A recognised innovation capacity (CEBB + ARD) - An accessible location close to Reims and Paris - A storytelling of the symbiotic biorefinery involving industries, farmers and coops - Coverage of the entire value chain from biomass to markets - Coverage of TRL scale from the idea to the industrial plant - Skills in industrial biotechnologies and plant based- and green chemistries	- Reputation still to be developed - Limited common facilities (plug and play approach to be developed) - Common governance not yet in place (on progress) - The limit and costs of infrastructures to be upgraded
OPPORTUNITIES	**THREATS**
- Significant assets in a fast-growing diversifying world biobased market - Favourable context for the bioeconomy and circular economy based on biogenic carbon - At the crossroads of diversified partnerships - Regional, national and European strategies	- Steadiness of activities of current stakeholders - Attractiveness of more and more other platforms linked to biobased development - Lack of consistency of public policy

Fig. 3. SWOT analysis of the biorefinery in 2021.

cal environment. Nevertheless, the power of the human combined with external opportunities is a recipe to build a "great adventure": "faster alone, further together".

The biorefinery concept is often considered as the (industrial) cornerstone of the bioeconomy. This example demonstrate that it is possible to produce on a same site, food, feed, biochemical, bioenergies - under different shapes – and cosmetic ingredients as well. In addition, the presence of a campus and an innovation platform open up a wide range of possibilities: "local anchoring and international influence", such is our challenge to face for the years to come!

This governance structure should in particular help the biorefinery to face its new challenges, such as extension upstream and downstream, the development of joint assets, preservation of values, the selection and integration of new partners and development of networks between different strata. Several weaknesses could be overcome by this structure:

(i) *Networking, strategic monitoring and strategic decision-making tools* … in keeping with the identities of each partners. Trust, dialogue and communication between the stakeholders despite their differences are needed and required: this is pivotal to keep the spirit of the founding fathers.

Currently, there are three layers of actors at the biorefinery. The first layer is made up of professionals on site: plant managers and their staff, ARD researchers, the operators of the pilot and demonstration units and CEBB researchers. Parent-organization management teams make up a second layer: the management teams of cooperatives, engineering schools/university and pilot scheme partners, together with their boards of directors. Outlying actors make up the third layer: local village communities, local authorities, the State and representatives of local people. There is currently a lack of mechanism to share information, monitoring and strategy discussion between these three layers of stakeholders.

(ii) *Technology transfer and exploitation of knowledge and skills* (as defined by Tallman et al., 2004; Grossetti et al., 2006). The biorefinery stakeholders continually look for possible optimizations, in an attempt to improve the "biorefinery system," and thus the system is constantly changing. Although improvements are still possible, the research work undertaken over many years has brought the site almost to an optimal situation in terms of energy use. A possibility for the optimization of the system would be to use low energy-demanding systems. This work could include integration of the needs of territory near the biorefinery site, which would strengthen links between the biorefinery and its local environment even further. One of the recent initiatives is a research project focusing on methanation. Methanation is a solution of the future that fits perfectly alongside methanization and pyrogasification units. The Grand Est region is particularly at the forefront in France for the injection of biomethane.

This research project aims to strengthen the energy and economic recovery of the biogas produced by methanation in the region, by combining it with a biological methanation process to increase the production of biomethane. This process relies on micro-organisms that produce biomethane from hydrogen, carbon dioxide (CO_2). Complementary to anaerobic digestion, this innovative process contributes to the creation of significant added value for the entire biogas production chain.

The technology developed is based on the use of a bioreactor for the accumulation of a specialized biomass combined with a membrane contactor to inject hydrogen into the bioreactor. The experiments carried out at the CEBB made it possible to demonstrate the feasibility of obtaining a gas with high methane purity. This innovative approach was patented in May 2020. In the near future, this innovative technology will be implemented on-site to overcome a concrete industrial problem. This renewable, non-intermittent and easily storable energy provides regions with concrete solutions in terms of support for agriculture, circular economy and waste treatment.

In the current context of the tremendous challenges and potential of digitalization and artificial intelligence, CEBB is working on a concept of "digital twin" of biorefinery processes which is a simulation of how production is actually being manufactured. This approach uses computers to model, simulate and optimize the critical operations and entities in a factory plant. It will thus become easy to create, simulate and implement a complete virtual factory/biorefinery. It will allow to optimize flows, integrate by-products and impact flexibility. The digital twin enables a stronger competitive position, reduces costs, and gets products to market faster.

This approach is complementary to other applications in "factories of the future" programs already in progress on the site.

(iii) *Financial engineering* such as assessing the technical-economic potential of the discoveries, assisting start-up companies before they apply to established venture capitalists, the great concern for confidentiality in initial development phases, the need to examine strategic decisions locally.

Traditionally, cooperatives used retained earnings and members' contributions to finance their activity. Today, like any other firm, cooperatives operate in a very different business environment. They need more funds to grow and remain competitive (extension and differentiation in the market), at a time when it is more difficult than ever to obtain funds. According to the values and principles that characterise agricultural cooperatives, in particular their long-term vision, private

equity or other models of "Green investments" could offer new means of invests.

At the crossroads of collective contribution of farmers via their coops, significant commitment of the local authorities and the “specific” funding scheme of start-ups (crowdfunding, fundraising), new ways for the innovation are still in the making…

(iv) *Promotion, attractivity and promising international perspectives of development.* Although the Bazancourt–Pomacle biorefinery was created upon local stakeholders’ will to generate more value to their productions, its reputation quickly transcended national borders as proven by the arrival of international firms such as Givaudan Active Beauty and ADM. Similarly, ARD is now an internationally-recognized leader in fermentation processes thanks to both its scientific expertise and BioDemo, its demonstration unit. This international visibility is not limited to industries (Givaudan Active Beauty, ADM) and private center (i.e., ARD). Indeed, despite its recent launch, the CEBB has rapidly become a global leader in green chemistry and recognized as such by Dr. John Warner, one of the two fathers of Green Chemistry. It is noteworthy to mention that Green chemistry is not the only scientific expertise that CEBB is known for as the four teams have on-going strong partnerships with research institutions all around the globe focusing on biotechnologies, biomaterials and down-stream process.

Although the industrial and academic players of the Bazancourt–Pomacle biorefinery have proven themselves strong experts in their respective fields, the global fierce competitions force them to continuously evolve to remain competitive. To keep the pace, they need to strengthen their expertise through relevant complementary partnerships with (inter)national entities. At the industrial level, the recent acquisitions effected by Givaudan Active Beauty (e.g. Naturex) perfectly illustrate this evolution. The CEBB, for its part, recently teamed up with synthetic biology experts (e.g., ABOLIS SA and Genopole) as this competitive expertise was not present in any of its teams.

Other partnerships are being discussed and will further expand the expertise and the international reputation of the Bazancourt–Pomacle biorefinery players… stay tuned.

Conclusion: past, present and above all the future

The Bazancourt–Pomacle biorefinery is the result of a unique, incremental, unplanned process. There was no initial master plan of development, even if visionary leaders foresaw its potential. Openness and search for innovation to overcome the weaknesses encountered and to adapt to changes were the driving force behind the dynamics.

These two criteria are a major contribution of the mutualism movement. Early, it encouraged farmers to be open and innovative and still today, this spirit is very strong in the farmers of Champagne who are constantly looking for progress to adapt to new conditions and context (Mangeart, 1999).

Today as yesterday, the world is changing but the spirit remains. The cooperatives and long term commitment are the guarantors of this. The perseverance of these values makes it possible to look to the future with optimism because they guarantee adaptability.

In 1992, Jacques de Bohan wrote about the emblematic door of the building housing the first Champagne agricultural cooperative and still preserved as a symbol: *“The forged door bears witness to the past and recalls the origins and values to which we are attached. The door is open, it invites you to pass: from Providence Agricole to Champagne Céréales.”* By this sentence, he invited farmers to move forward - with confidence - on the basis of a foundation “forged” by collective action like, similarly to Victor Hugo who said *"the future is a door and the past is the key"*. In the current changing world, once more, this openness to progress and innovation, supported by common values, is the prerequisite for adaptation in a steady evolution.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Florent Allais: Writing - original draft, Writing - review & editing. **Honorine Lescieux-Katir:** Writing - original draft, Writing - review & editing. **Jean-Marie Chauvet:** Writing - original draft, Writing - review & editing.

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