Bioleft: Beyond an open source seed system

How can the ideals of the open source movement be applied to living, self-replicating organisms? Bioleft explores how to pursue a fair system for conserving, developing, and trading seeds working with public sector breeders and farmers hand in hand.

By Almendra Cremaschi, Patrick van Zwanenberg, Anabel Marín, Marcela Basch, and Vanesa Lowenstein

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In the context of the expansion of ever stricter intellectual property rights and the growing sustainability challenges the world is facing, collaborative, horizontal, and commons oriented forms of production are of high value. The potential for democratizing and diversifying knowledge and innovation is demonstrated by the success of free/open source software, which has been inspirational for many other fields like science, hardware, and farm equipment [1].

Seeds are also a good example. The open seeds movement shares with open software an aspiration to democratize knowledge, and to promote its wide circulation and progressive collective enrichment, in order to build a more diverse food system. However, plant genes are not homologous to software code. Taking open source ideas from the abstract to the physical is challenging, but this challenge also represents an opportunity for learning. In this article, we describe an open source seeds experience, called Bioleft, which while trying to free germplasm from proprietary control is also trying to support a more sustainable, democratic, and diverse agriculture, where there are more diverse seed varieties, farming practices and communities are supported, and innovations are not only those that are most profitable but also those oriented to satisfy people's needs. In doing so, it is bringing to light some of the complexities behind the code.

We are learning a lot from the software-oriented open source movement, using intellectual property laws and contracts to guarantee the continued freedom of farmers and breeders to share, use, distribute, and improve seeds. We are also fostering participatory seed breeding by supporting experimentation with new varieties and co-designing a virtual fieldbook to support peer-to-peer breeding. What seems interesting is that in doing so, we are also building new networks, balancing power relationships, dealing with language barriers, and building shared visions about what sustainable agriculture might mean.

THE PROBLEM

Seeds have been "written" for centuries by farmers, who have adapted them to their production needs by selecting and exchanging not only seeds but also practices related to them. The

Image by Nopparat Promtha

free circulation of knowledge was key to agricultural improvements.

Companies did not participate in this process because it was difficult to generate a return on their investments in R&D. Instead seed breeding was led by farmers and later by state institutions. But the technique of hybridization in the 1930s, and then genetic engineering half a century later, has helped to create new technical and legal forms of appropriation respectively, encouraging the interest of private companies and the creation of markets [2].

Seeds went from being mostly managed within a commons to becoming market goods. Once genetic engineering offered new forms of appropriation, seed breeding and commercialization changed from being distributed between hundreds of medium- and large-seed firms and public institutions to increasingly concentrated in very large private companies that have focused on the development of genetically uniform, high-yield, high-input demanding seeds [2, 3, 4]. This growing concentration is associated with multiple sustainability challenges [4].

One such challenge is the risk of losing ever more biocultural diversity, which refers to both the loss of crop biodiversity, and the practices and knowledge associated with farmers and agricultural communities that have improved seeds during centuries [5].

Another challenge is the shifting focus and even loss of public breeding capabilities [2]. While public breeders continue to develop new seed varieties, they do not possess distribution infrastructure. Therefore they depend on local companies to distribute their seeds, which require licences that give them exclusive rights in return for royalties paid back to the public sector.

One of consequences of this is the public sector breeds certain kinds of seeds at the expense of others, mostly those oriented to larger scale, high-external input commercial agriculture, which seed companies are most interested in commercializing [3].

There are many initiatives trying to address these kinds of sustainability challenges related to seed market concentration. Yet, despite their value, they tend to remain local and face difficulties to scale up. One of the reasons for this is related to highly contested views around the functions of seeds and what a more sustainable agriculture means [6].

Addressing these sustainability problems requires to deal with such contested views. In this context, spaces of co-production have a great potential to build alliances between people who have different perspectives, but may find certain points of consensus or even reframe their own visions in search of more collective projects [4].

Open source seed licences may also have a bridging function, attending to the expectations of contrasting stakeholder groups—from seed firms interested in accessing germplasm for breeding to farmers seeking to recuperate traditional forms of

collaboration [4]. Open seed systems seek to democratize knowledge and promote its circulation and progressive collective enrichment to build a more diverse food system.

OPEN SOURCE SEEDS

Given concerns about the sustainability challenges mentioned earlier and taking inspiration from the free/ope source software movement, many initiatives around the world are exploring the development of open source seed systems. Although taking different forms depending on local conditions, such systems are based on the creation of a licence or pledge, equivalent to the General Public Licence (GPL) developed by Richard Stallman when he started the free software movement for software coding. In fact, open source seeds shares with GPL its viral condition, which mandates any software that incorporates source code already licensed under the GPL will itself become subject to the GPL. When the resulting software product is distributed, its creator must make the entire source code base freely available to everyone, at no additional charge [7]. As it can be seen, here "viral" has a positive connotation, because it ensures the further availability of the original software code and its modifications.

When it is applied to seeds, the viral clause states that they, as well as their progeny and derivatives, can be saved, used for research or replanting, and traded and improved without any restrictions provided that the beneficiaries (farmers, breeders, or researchers) agree to pass those freedoms to others. This means no one may restrict seeds or their progeny for further distribution, and thus, open access to plant genetic resources will be maintained. Unlike software, however, seeds reproduce themselves, which created one of the biggest challenges of open seed initiatives: monitoring and enforcement [1, 4, 8].

BIOLEFT

Bioleft is an initiative that began with a transdisciplinary group of sustainability researchers from Argentina in 2015, in the context of a research project about transitions to sustainability [4]. We define Bioleft as a community lab that develops knowledge and seed varieties suitable for diverse agricultural practices, particularly for small farmers and ecologically benign forms of agriculture. With this purpose, we have co-designed two main tools: An open source licence to protect the seeds from exclusive appropriation and a digital platform, which collects information about users, seeds, and crop performance.

Knowledge cannot be separated from the physical material. The scientific, practical, and tacit knowledge used to create seed crosses is embodied in plant germplasm.

Institutional tool: The licences. Bioleft has established a legal instrument for the transfer of genetic material (seeds) that ensures such material will remain freely available for the purposes of R&D and for the registration of new seed varieties. This instrument functions in parallel with existing intellectual property legislation, as a clause that can be added to contracts or material transfer agreements. It's flexible in terms of conditions of use, but it will always include a "copyleft" clause that ensures improved seeds bred from Bioleft material will also be Bioleft.

The idea for developing such a license arose in discussions and workshops with plant breeders, farmers, and other organizations [4]. This made it clear that funding restrictions faced by public institutions means the royalties from companies who multiply and distribute seeds bred by public sector breeders are seen as critically important. This situation led us to reflect on the limits of an entirely open license since the inclusion of public breeders is essential for a more collaborative seed system. Inspired by the experience with Creative Commons, we therefore developed three different open source seeds licenses with a range of attributions. These range from granting users the freedom to use seeds for any purpose to exclusions on the ability of users to sell seeds. However all three maintain a copyleft clause that requires the seeds varieties and all progenies can be saved, reused, used for research, breeding, and the development of new varieties.[1]

Technological tool: The web platform. Questions and challenges concerning seed traceability and enforcement of the licences made us think of a web platform that could gather information about seeds and users to map seed transactions. Given that seeds are self-replicating and interact by sharing pollen and genomic information, this represents a major challenge for both traceability and enforcement. Illegal markets, in fact, also represent a significant proportion of the local seed sales. This, together with our limited institutional capabilities, required long reflections about the implementation of the licences.

A web platform appeared to be very useful in this regard, because it could make use of collective intelligence to register and map seeds and users. The involvement of a diversity of stakeholders in the process showed the web portal's potential was far higher. It could support participatory breeding, connecting public sector capabilities with farmer demand and recuperating the role of farmers as breeders, instead of being seen as mere consumers.

The development of a virtual platform for participatory breeding requires the design of a fieldbook, where data can be gathered in the field and shared over the internet. The relatively low cost of the internet makes it a great alternative to conventional breeding. Through collaborative and decentralized plant testing, as with the experience of Linux, it has the potential to compete with private companies' innovation models, which are based on field-testing networks.

Producing a virtual platform of participatory breeding is challenging. There are currently a few online platforms and fieldbook apps, but

1 https://bioleft.org/en/licencias/

they are all oriented to professional breeders and are not intuitive nor useful for farmers and for the traits and varieties they are interested in observing and developing. Developing collaborative fieldbooks between farmers, breeders, and extension workers requires an ongoing balancing of power relationships and knowledge negotiation.

Typically, academic knowledge has legitimacy and public recognition, while traditional, local knowledge is seen as not valid enough for doing research. It was therefore necessary to design a methodological process for helping farmers to recognize the value of their own knowledge, which was said to be "too qualitative and without statistical value." Negotiating the objectives of breeding was also an interesting process. Breeders were focused on increasing plant yields, but overlooked the cost-benefit relation in developing high yields, as well as high-input demanding seeds. Farmers seemed to have a more systemic vision, where they highlighted interactions between plants and the rest of the system (soil, weeds, economy, etc.).

The co-design process of the platform is still ongoing. It might take considerably longer than a conventional software development, but by carrying out a collaborative construction we seek to build much more than software. We are building a systemic platform for a more sustainable seeds system.

CONCLUSIONS

Open seed systems have a lot to learn from free/libre and open source software. However, seeds and code are not equivalent. First, although software code can be read and completely understood by developers, we do not know enough about DNA sequences to make such a claim. In fact, most plant varieties' genomes are complete black boxes for us. Second, unlike software and hardware, knowledge cannot be separated from the physical material. The scientific, practical, and tacit knowledge used to create seed crosses is embodied in plant germplasm. Third, while software can be created from scratch, seed improvements are always cumulative; they are based on the selection and breeding conducted by farmers for centuries, and more recently on innovations developed by professional public and private breeders.

Bioleft, as a systemic open source seed initiative, could be useful to illustrate some of the processes, challenges, and potential of working with biocultural diversity in general and seeds in particular. It was evident from the first stages of the project that a horizontal and transdisciplinary approach was needed. From an initial team of three researchers (an innovations specialist, an environmental scientist, and an agronomist) we have grown to 14 people, including lawyers, farmers, breeders, anthropologists, software developers, and communication specialists.

Although the flexibility of the developed licenses can be seen as a bit restrictive and even against the spirit of Bioleft, working with and including a wide range of stakeholders requires permanent negotiation and envisioning of the most sustainable, but also, possible futures. The engagement and empowerment of public breeders, willing to build a germplasm pool of genetic material that cannot be monopolized by private interests, made us raise awareness about the need of the system to be flexible—to truly respond to the needs of all the stakeholders. More interestingly, it also helped us to see the development of open source methods limits the leading role to one of coordination and motivation, releasing ownership and decision making to the whole group [1]

Co-developing a web platform for participatory breeding is a very motivating process. People are strongly committed to work long hours in workshops, meetings, and field visits—even without a salary. The methodological design, based on participatory techniques, has been of great help dealing with power tensions, but also fostering creativity and the ability to play. We are still facing multiple challenges for scaling the project. They are mainly related to fundraising, knowledge systematization, and enforcement capacity.

The reflections expressed within try to explain how challenging it is to develop alternative seed systems using the lessons from open source software, but they also represent an opportunity of learning from experience, and building synergies while contributing to open source movement.

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Biographies

Almendra Cremaschi is an agronomist who graduated from the National University of La Plata, Argentina. She is interested in issues related to rural development and family farming, as well as multidisciplinary work and participatory methodologies to address complex problems such as sustainability.

Patrick van Zwanenberg has a degree in environmental sciences and a Ph.D. in science and technology policy studies. He combines tools from the social studies of science and technology with science policy. He is interested in the politics of knowledge, technology regulation, and how innovation processes can be transformed to better respond to social needs and values.

Anabel Marín is a researcher on issues linking innovation, science, technology, and development. She is interested in the use of multidisciplinary approaches to address issues of economic and social development that are sustainable and inclusive.

Marcela Basch holds a bachelor of letters, journalist and teacher. Since 2013 she has researched and covered topics of collaborative economies and free and open culture. She is the founder of the portal El Plan C and co-organizer of the Collaborative Economy Week and the Comunes international conference.

Vanesa Lowenstein is a lawyer specializing in intellectual property, knowledge management, and innovation. She has worked for public entities like the Ministry of Science, Technology and Innovation, Agriculture and Production at the national and international level. She is also a teacher and researcher interested in the creation of policies, regulation, and impact analysis that the appropriation and circulation of knowledge have on development.

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