Analysis
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Information, knowledge, innovation: the other side of food system globalization

The *MOND'Alim 2030* exercise led by the Centre for Studies and Strategic Foresight (CEP) looks at the current phase of food system globalization and documents the core dynamics at work. One of its chapters is devoted to the circulation of information, the production of knowledge and the dissemination of innovations. The present note identifies the broad structural issues and formulates some hypotheses for the future: growing international integration of information systems, a preponderance of global corporations in R&D, globalization of ideas and the renewal of agricultural paradigms.

The globalization of food systems is not limited to trade in basic or processed agricultural products. While cereals, milk powder, etc., are increasingly circulating around the planet, we are also drawn into a powerful whirl of ideas, data and technologies. Inventions and innovations are frequently more mobile than goods, land or people. Some are central to international processes and play a driving role (e.g. logistics, information and communication technology), while others only accompany the expansion of global distribution networks.

Far from neutral, disembodied circulation of information, this facet of globalization needs to be seen in terms of inequality, conflicts between values, power relationships and actors' strategies. It confronts different visions of technical progress and offers opportunities for some, while creating a risk of marginalization for others. It subverts local innovation regimes (informal collective ownership, national public research, regional cooperation). This does not mean however that the globalization of information, ideas and knowledge is simply destabilizing; it also constructs "solutions for tomorrow" that organize a variety of data sets and inventions, new intellectual property systems and domains of technical innovation.

This article describes the broad trends at work within food systems as regards (1) data and information systems (2) R&D and its financing, and (3) paradigms, models and counter-models for agriculture and agrifood. In each case we discuss the challenges for the actors and public policies and we also formulate hypotheses for the period to 2030. For further details interested readers should refer to chapter 3 of the *MOND'Alim 2030*[1] report.

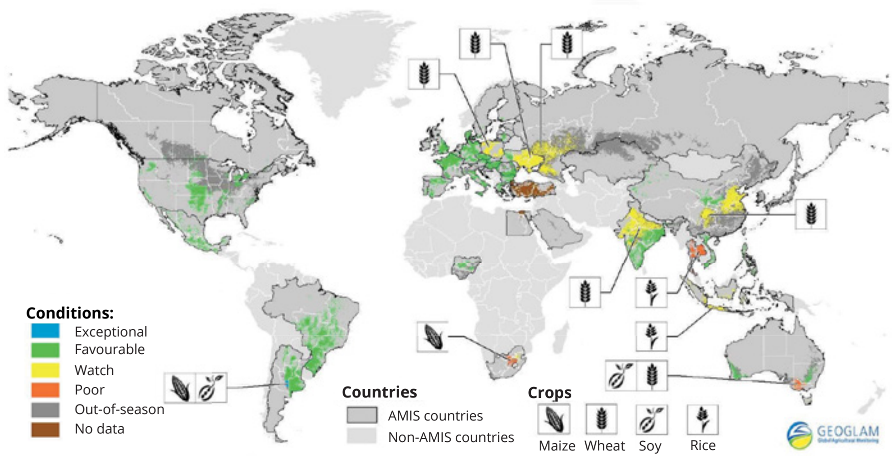
1. The globalization of data and information systems: new technologies, new actors

The globalization of data and information relevant to food systems is not a new phenomenon. In the second half of the 20th century, international organizations (UN, World Bank, IMF, WTO, among others) put in place a series of databases and tools for monitoring and periodic reporting to provide a better description of the planet's ongoing development in agricultural production, food security, trade, etc., so as to better target their actions. FAO-Stat is the archetype for this. It is a portal for access to data series going back to 1961 for all countries in various domains: agriculture, forestry, fisheries, land and water resources, climate, environment, population, nutrition, poverty, rural development, education, health, and others.

Nowadays, international organizations and national governments continue to play a central role in the production and circulation of data. For example, beginning after the hunger riots of 2007-2008 and the setting up of an agricultural market information system (AMIS), every month the Group on Earth Observation produces maps showing the status of crops around the world in order to foresee insufficient production (cf. figure 1). Another example: the FAO , in conjunction with the World Bank, has implemented a global strategy focused on technical assistance and training for personnel in the statistics agencies of developing countries.

1. Claquin P., Martin A., Deram C., Bidaud F., Delgoulet E., Gassie J., Hérault B., 2017, *MOND'Alim 2030, panorama prospectif de la mondialisation des systèmes alimentaires*, Paris, La Documentation française.
http://agriculture.gouv.fr/mondalim-2030
http://www.ladocumentationfrancaise.fr/ouvrages/9782110103314-mond-alim-2030?xtor=EPR-528

Figure 1: **AMIS crop monitor map (February 2016)**



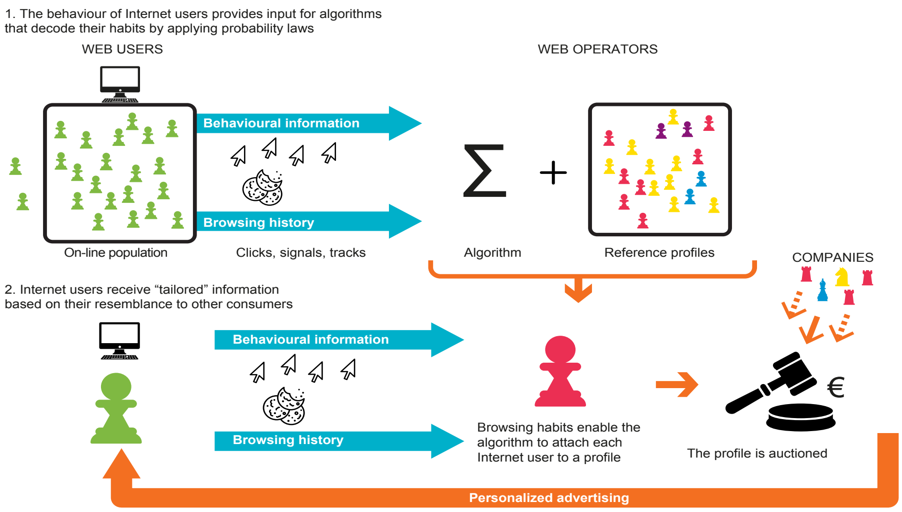
Source: Geoglam, https://cropmonitor.org/

At the same time, we observe a rise in the influence of private actors as providers of data and information systems. Multinational corporations often have information sources (e.g. locally-based plants, services from third parties) which produce, for their sole benefit, market data more suited to their needs than official figures. Companies such as Planetretail, Euromonitor and Statista develop market information tools for use by business. Their work is based not only on public information but also on data collected form their customers and on their own econometric simulations.

In the agrifood sector, part of web marketing is making increasing use of "big data" algorithms to reach out to consumers and to personalize advertising. "The future of the Internet user is predicted by the past of those who resemble him or her"[2] (cf. figure 2). These technologies can be easily assimilated into commercial systems and optimize the fit between supply and demand based on better knowledge of them at various levels from the most local to the most global. As they are disseminated simultaneously *via* smartphones and Internet access, they encourage further globalization of food systems at both stages, not only consumption but also production, using precision agriculture.

Governments must adapt to a rapidly changing context encompassing a multiplicity of initiatives: collaboration programmes with international agencies, internal flows in global firms and financial reporting, circulation of market information *via* mobile telephones within network architectures[3], and so on.

Figure 2: **Predictive marketing, advertising or information?**



Source: *MOND'Alim 2030*, after D. Cardon[2]

For example, in East Africa, generalization of the use of text messages since 1997-1998 has allowed a new generation of market information systems to emerge, systems managed more often by private operators, and with a geographical scope extending beyond national borders, such as the Agricultural Input Market Information and Transparency System (AMITSA), for monitoring farm inputs, or the Regional Agricultural Trade Intelligence Network (RATIN), a regional information system linked to the major actors in the cereals sectors. Compared with other sectors, agrifood continues to be characterized by very limited formalization and weak integration of informations at global level. But the implementation of dense technological networks (e.g. satellites and GPS, computers, smartphones, connected tools, drones) is bringing about significant change in this situation.

The same movement towards the integration of local information into global systems, with no official filters, is operating in the area of participatory research in programmes that bring scientists and amateur volunteers together for the collection of data. Such "citizen" sciences have notably developed in connection with naturalist inventories. The Geo-Wiki project is an example of this, combining as it does the land utilization data from three world databases, and using volunteers to reconcile differences between those databases on the basis of Google images. The number of ways of circumventing what was until recently a public quasi-monopoly on data will increase over the period to 2030, thus redefining the hitherto pivotal role of governments and international organizations.

New regulatory issues are appearing in this context, especially in the areas of ownership and value transfer, national sovereignty and the security of sensitive data, as well as the protection of privacy and consent to the use of personal data. With "big data", new actors from the digital economy are infiltrating food systems. Their arrival reinforces the "technical packages" of global firms concerned to extend their market offering, as suggested in 2013 by Monsanto's acquisition of Climate Corp, a start-up specializing in climate forecasting.

A number of regulatory approaches have been initiated since the mid-2010s to encourage balanced development of

2. Cardon D., 2015, *À quoi rêvent les algorithmes. Nos vies à l'heure des big data*, Seuil, p.34.
3. David-Benz H. *et al.*, 2011, "Les systèmes d'information sur les marchés agricoles en Afrique subsaharienne. De la première à la deuxième génération", *Focales*, 14, AFD.

e-agriculture. In the United States from 2014 to 2016, the American Farm Bureau Federation (the majority union), the main actors in the agricultural sector and platforms (most notably Climate Corp and the Farmers Business Network) adopted a charter on confidentiality and data security, followed by a secure platform and, lastly, an "Ag Data Transparent" production label[4]. Alongside this, more open schemes based on "open access" principles are currently being developed in Europe[5]. The stabilization of regulatory models, followed by their dissemination, or even their imposition as standards or as "good practice", will therefore be important for the exercise of influence in the years to come.

Similarly, ensuring the reliability of data could become a new key issue for globalized food systems. This is so because the extension of value chains poses previously unseen problems for the maintenance of trust. By 2030, information evaluation activity will be a major economic sector, involving a series of new contributors (data scientists, data checkers) to strengthen companies currently working in the field on the certification of compliance with various specification sets (e.g. organic production, "responsible" consumption, environmental labels). The effort to track commitments will in this way lead to a degree of bureaucracy which will be met by its own counter-trends: examples of this are the expansion of short distribution channels and the creation of participatory guarantee schemes not involving third-party assessors. Technical solutions will also arrive on the market. For example, in the area of transaction security, blockchains encourage decentralized management, making it possible to "avoid the necessity of a central trusted authority"[6].

2. The globalization of R&D and the rising importance of emerging countries and multinational companies

Cosmopolitan research serving global goals and issues

Over the last three decades, research has been essentially liberated from national agricultural goals and issues, becoming increasingly cosmopolitan and focused on global goals and issues. The appearance of common challenges has speeded the emergence of wide-ranging programmes involving teams from around the world to achieve economies of scale, dividing the work into more or less standalone packages and facilitating access to data. This is true of genome mapping projects, which generated several waves of innovation and strengthened the move towards concentration of project resources[7]. Another example: more recently, the Ag-MIP project has gathered together climatologists, economists and agronomists based on different continents to characterize the effects of climate change on agricultural production and food security.

The worldwide debate surrounding expertise is a sign of the growing scientization of public policies in the food domain. Public action is increasingly based on academic conclusions. Global competition between actors in both the public and private spheres requires that both words and actions should be based on evidence. More and more often, research communities are being asked to address topical issues. Conversely, scientists are questioning politicians and seeking to exert influence on the public agenda by taking part in committees, think tanks, networks, and so on. The implementation of evidence-based policies implies that knowledge is being compared, contrasted and distilled, using "meta-analysis" to generate robust overall conclusions. We are witnessing the incremental construction of a global space for scientific knowledge facilitated by access to publications *via* web portals.

The outcome of these developments will not necessarily be a unified scientific vision of the world. This is one lesson drawn from the International Assessment of Agricultural Science and Technology for Development (IAASTD), which was conducted during the years 2005-2008 with World Bank and United Nations sponsorship for the purpose of evaluating the contribution of agricultural research and agricultural technology to achievement of the Millennium Development Goals. Its assessment, which involved 57 national governments, representatives from the agricultural and food industries and the academic and development world, also highlighted disagreements, especially with respect to precautions on GMOs and agricultural market regulation, with some stakeholders refusing to endorse the report's conclusions[8].

Emerging countries' expanding role in R&D

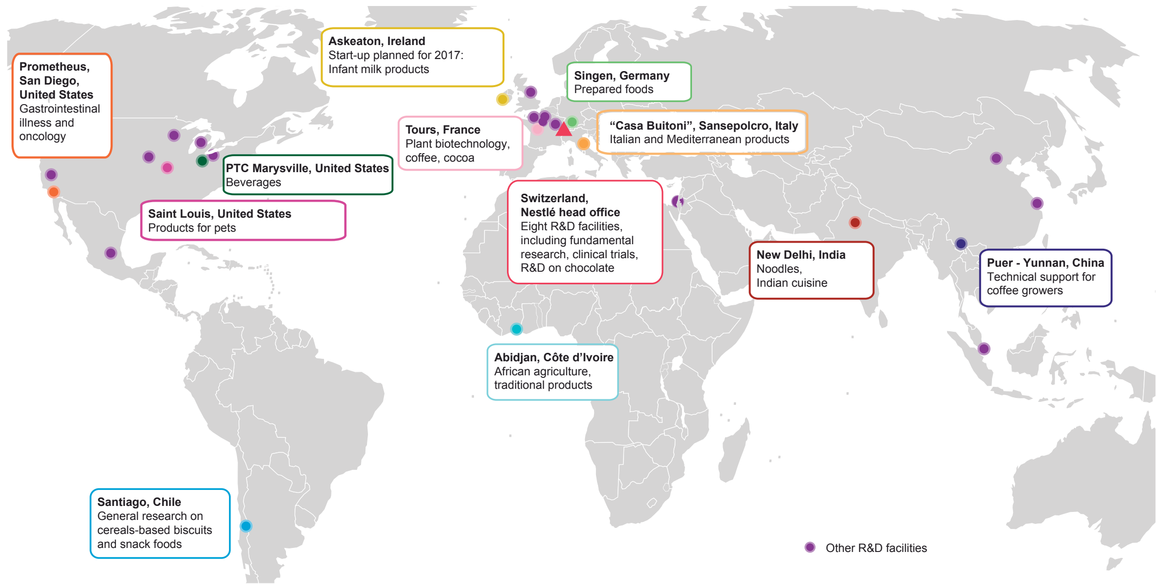
Although public efforts in agricultural research are stuck at a very low level in "low-income" countries exposed to volatility in international aid, the figures confirm significant progress in "middle-income" countries, which are experiencing rapid economic growth[9]. In contrast to this, expenditure has plateaued in the most developed geographical areas, rising by 1% annually in the early 2000s, compared with +9% in the 1960s. At that time, the United States accounted for 21% of global public research, China for 13%, India 3% and Brazil 2.5%. In 2009, these percentages were, respectively, approximately 13%, 19%, 7% and 5%[10].

Agriculture in high-income countries is nonetheless an ever more intensive user of research (with a ratio of USD0.56 invested in research for every USD100 of production in 1960, compared with USD3.59 in 2009). It also extends further downstream to environmental protection, sanitary quality and rural development. Conversely, agriculture in emerging countries, currently focused as it is on increasing yields and adapting developed-world agricultural technology to local conditions, is achieving greater productivity gains.

Major multinational firms' choices when locating their R&D facilities (cf. figure 3) further energize emerging countries with location strategies aimed, according to case, at taking advantage of specific resources, developing products and innovations close to markets or alternatively, through mergers and acquisitions, at controlling new processes and expanding collections of varieties and genes. In some cases, their choices also help circumvent regulatory or political barriers – opposition to GMO research, for example.

4. Malvezin C., 2016, "Lancement de l'Agricultural Data Coalition et du Ag Data Transparency Evaluator aux Etats-Unis", CEP sector watch blog, http://veilleagri.hautetfort.com/archive/2016/05/17/lancement-de-l-agricultural-data-coalition-et-duag-data-tra-5802925.html.
5. Réseau Numérique & Agriculture, 2016, *L'accès aux données pour l'innovation et la recherche en agriculture*, ACTA, http://www.acta.asso.fr/actualites/communiques-de-presse/articles-et-communiques/detail/a/detail/livre-blanc-0591.html.
6. Berbain C., 2017, "Le blockchain : concept, technologie, acteurs et usages", *Annales des Mines – Réalités industrielles*, 3, pp.6-9.
7. Hervieu B., Joly P.-B., 2003, "La marchandisation du vivant. Pour la mutualisation des recherches en génomique", *Futuribles*, 292, pp.5-30.
8. Even M.-A., 2009, "L'IAASTD : une expertise internationale qui marque un changement de paradigme pour l'agriculture et le développement", *Analyse*, no 6, http://agriculture.gouv.fr/telecharger/63683?token=d124b6e9fd3a16dc4219fd13c75707f9.
9. Beintema N. *et al.*, 2012, *ASTI global assessment of agricultural R&D spending. Developing countries accelerate investment*, IFPRI, 22 p.
10. Pardey P.G. *et al.*, 2014, "Investments in and the Economic Returns to Agricultural and Food R&D Worldwide", in Van Alfen N.K., *Encyclopedia of Agriculture and Food Systems*, Volume 1, Elsevier.

Figure 3: **Nestlé: a global R&D network**

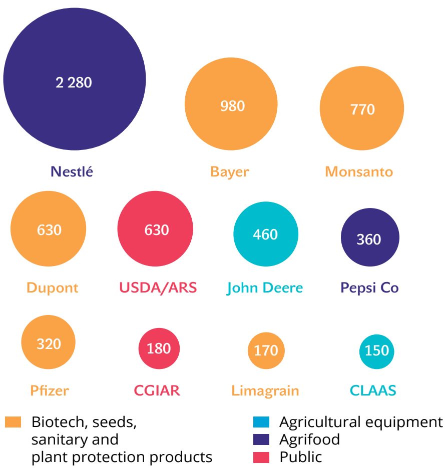


Source: *MOND'Alim 2030,* page 87, information taken from Nestlé's website (H1 2016)

A preponderance of private R&D

Public and private research have always been mutually complementary, with the public sector supplying the main investment in fundamental research and domains offering little market incentive: ecology, the human sciences and, for many years, nutrition, sanitary security, among others. But today innovation in food systems is increasingly being driven by corporate funding (cf. figure 4).

Figure 4: **R&D budgets – comparative public/private levels**



Source: *MOND'Alim 2030,* page 86, figures for 2007 taken from Fuglie K., *et al.*, 2011, and corporate financial reports (USD millions)

In the rich world, the rate of growth in private spending since the 1970s has been faster than for public spending. Such expenditure currently stands at approximately USD17bn invested annually, amounting to 40% of all global agrifood research. Of that total, 90% was disbursed in developed countries and 46% in processing industries (food, beverages, tobacco)[11]. In agricultural upstream sectors (agricultural equipment, seeds, fertilizers, plant protection products, health, nutrition and livestock breeding), "A relatively small number of large, multinational firms with global R&D[12] and marketing networks account for most R&D". This has followed the trend towards corporate concentration[13].

Governments have been urging research bodies to build public/private partnerships (PPPs) since the 1980s for budgetary reasons and due to a concern for closer connections to markets. The multinationals, in addition to lobbying national regulatory bodies, are also keen to channel R&D by offering study grants and research contracts. Encouraged by initiatives such as the G8 New Alliance for Food Security and Nutrition, the tendency is for PPPs to form "the new global framework"[14] for international aid. The effect of this type of strategy is to integrate family farming, hitherto disconnected from the rest of the world, into global value chains.

With the expansion of biotechnology, private R&D has now reached a rate of investment in the plant improvement sector that is comparable with the pharmaceutical industry. Alignment on the patent regime is now being promoted in order to give investors security and provide the necessary incentives to enter developing markets. Faced with this major trend, activists and researchers point to a risk of a lock on innovation at global level due to pre-emptive strategies aimed at building barriers to entry or capturing resources previously treated as common goods. It is also possible to see situations with overlapping patents, exposing innovators to a risk of patent infringement or litigation by seed producers concerned to preserve their royalties. This points to the possibility of private appropriation of resources that form part of humanity's common heritage.

These questions will still have topical relevance in 2030. Even if the innovation regime is tightly channelled, or even dominated, by global enterprises, national governments and international organizations will continue to have enough room for

11. Pardey P. G. *et al.*, 2014, *art.cit.*; see also Pardey P.G. *et al.*, 2016, "Agricultural R&D on the move", *Nature*, 537, pp.301-303.
12. Fuglie, K.O. *et al.*, 2011, *Research Investments and Market Structure in the Food Processing, Agriculture Input and Biofuel Industries Worldwide*, Economic Research Report, 130, U.S. Department of Agriculture.
13. These aspects are addressed in more detail in chapter 5 of *MOND'Alim*: http://agreste.agriculture.gouv.fr/IMG/pdf/analyse1111801.pdf.
14. Binet N., 2014, "Le rôle des entreprises et des fondations privées dans la gouvernance mondiale agricole et alimentaire", *Mondes en développement*, 165, pp.23-36.

manoeuvre to intervene. They will have an important role to play in the areas of control, regulations and enforcement.

3. The globalization of ideas, paradigms and models

In the future, food systems will be characterized by hybridization of the technical and organizational options of paradigms currently seen as opposed.

3.1. Renewal of conventional agriculture and the development of alternative models

The "Green Revolution" has referred since the Second World War to a modernization project aimed at a rational reorganization of agroecosystems. Improvements in genetic material and external inputs to the agroecosystem (e.g. plant protection products, mineral nitrogen, feed concentrates, antibiotics and growth regulators) allow local factors to be neutralized, in particular those related to sanitary, soil and climate conditions, in order to achieve optimum yields. This artificialization paradigm, which has been a major contributor to providing food for the world, in quantity as well as quality, is increasingly criticized due to its environmental consequences. Two trends do however seem capable of giving it a new lease of life and legitimacy: progress in biotechnology and progress in robotization linked to digital technology.

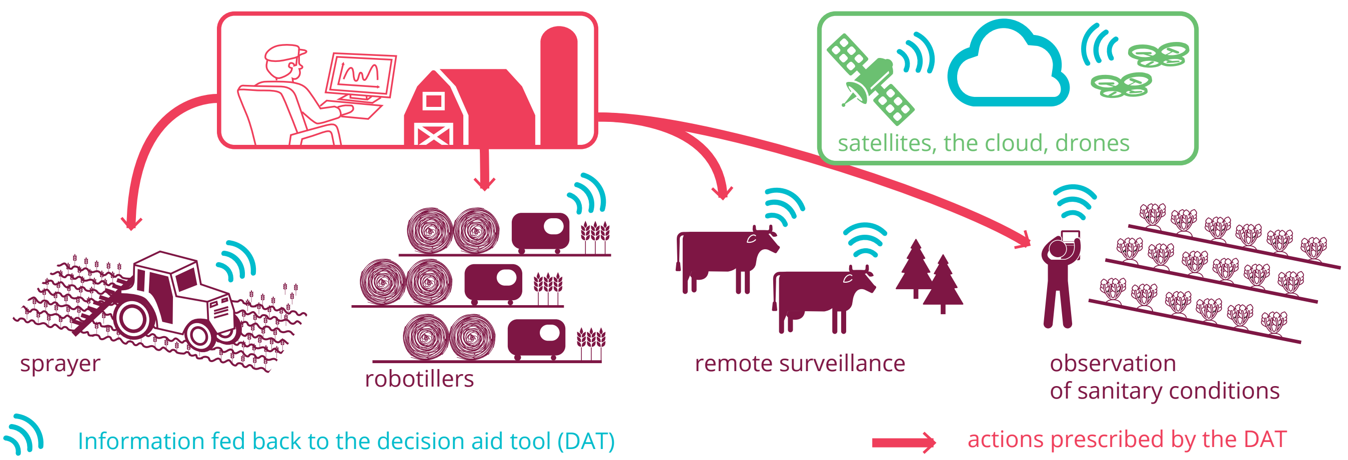
Where biotechnology is concerned, although the global spread of GMOs needs to be seen in perspective (areas shrank for the first time in 2015), new processes are tending now to replace transgenesis. For example, genomic selection (aka marker-assisted selection) allows rapid varietal progress to be obtained without genetic manipulation and raises little opposition. Conversely, certain developments are likely to be the subject of considerable debate over the period to 2030: mutagenesis and genome editing techniques (Crispr-Cas9). Given that these create organisms indistinguishable from natural organisms, they pose problems of regulatory qualification for national regulatory authorities. Opponents of these technologies point to the marketing of new "hidden GMOs". Worldwide dissemination might therefore be impeded by national decisions (more or less extensive authorizations or prohibitions, mandatory separation of sectors, adoption of labelling), leading to an increasingly fragmented biotechnology world.

A second trend that may prolong the life of the artificialization paradigm is the development of precision agriculture based on robotics and digital technology (cf. figure 5). In crop production, a combination of four technologies (GPS, geographic information systems, computer miniaturization, onboard sensors for agricultural machinery) make it possible to apply precisely the required quantity of fertilizer or pesticide at precisely the right time with due consideration for variations within parcels[15]. In the case of animal production, farming is assimilating industrial ecology schemes that enhance the efficiency of resource use, co-products and waste (e.g. utilization of heat) and close the main biogeophysical cycles more effectively (the water, nitrogen, carbon and phosphorus cycles), with for example the installation of biogas plants to produce energy from livestock manure. The adoption of such new technology packages is centred on North America. Latin America is a second locus, and has a comparable context: large holdings, industrialized agriculture, major R&D and agricultural advisory infrastructures, and so on. In Europe, interest has lagged behind, and is being driven by new environmental regulations and modernization policies.

More generally, the challenge for agricultural scientists and husbandry experts is how to reconfigure production systems to remove certain core elements such as pesticides, labour and GMOs, replacing them with alternatives that do not have the same unwanted effects. For example, simplified crop techniques (SCT) involve abandoning tilling in favour of seeding directly into plant cover. These methods were developed in the United States as a response to problems of erosion and were then exported to South America as part of a technical package – "direct seeding – glyphosate - Roundup Ready soybean" – conducive to large increases in yields. Researchers and agronomy consultants raise awareness of these methods among actors in the cooperative world in the context of study trips and training courses[16].

15. Hostiou N., Meuret M., Tichit M., 2014, "Élevage et pâturage 'de précision' : l'animal sous surveillance électronique", *Courrier de l'environnement de l'Inra*, 63, pp.13-24.
16. Goulet F., Hernandez V., 2011, "Vers un modèle de développement et d'identités professionnelles agricoles globalisés ? Dynamiques d'innovation autour du semis direct en Argentine et en France", *Revue Tiers Monde*, 207, pp.115-132.

Figure 5: **Connected agriculture – a reality by 2030**



Source: the authors, *MOND'Alim 2030*, page 90

However, the no-till approach has specific features in Europe: it dispenses with GMOs and seeks to reduce the use of glyphosate in preference to solutions such as soil plant cover and longer crop rotations.

Countering the artificialization paradigm, agroecology claims to be an alternative model for responding to food and environmental challenges out to the 2030 horizon. It is based on knowledge of the functioning of agroecosystems with the aim of enhancing biodiversity, strengthening biological regulation and closing biogeochemical cycles (nitrogen, phosphorus, carbon, etc.). There are signs to support expectations of a more favourable context for agroecology at the 2030 horizon. In order to take it beyond its current status as a niche innovation, some countries are encouraging its development. Responding to consumer expectations, the market is beginning to promote it as a guarantee of positive outcomes for health and the environment.

Agroecology does nevertheless face obstacles. Innovation pathways are "locked in" to a limited number of actors and instruments by mechanisms that are all the more powerful because they operate at the global scale[17]. Patents, technical standards and marketing norms, types of funding and the interplay between actors make it increasingly a global system and encourage the spread of standardized technical solutions able to be transposed with only a minimum of agricultural advisory services. In years to come, tension could therefore arise, with respect to GMO use for example, which is now being considered by the inventors of push-pull technologies[18]. Paradoxically, over the period to 2030, the growing institutional recognition and hybridization of agroecology could lead to a crisis in the social movements currently advocating it.

3.2. Towards a planetary reconfiguration of sectors

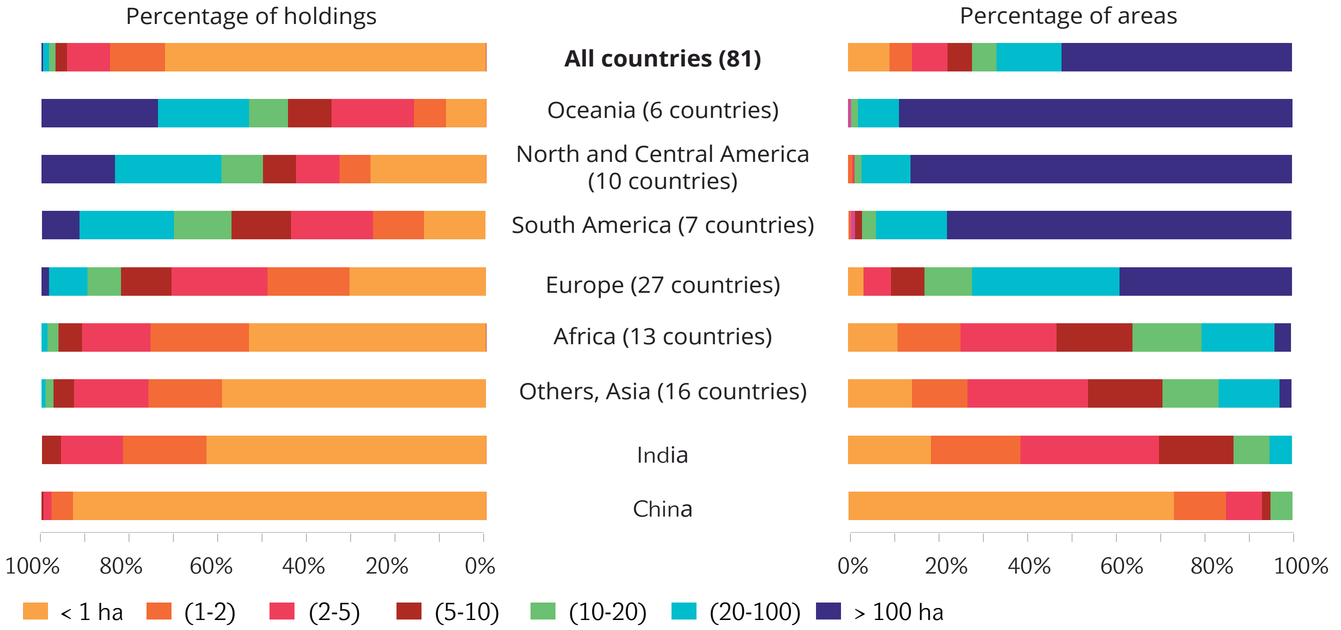
While the "Green Revolution" and agroecology strategies were built around technical production pathways, other paradigms are polarizing around the organization of the factors and structures of that production. Family farming versus corporate farming[19], small versus large holdings: despite, or due to their schematic approach, these binary models, each claiming to be universal, make it possible to bring closer together disparate realities and contribute to vigorous debate of the global issue of food.

Indeed, everywhere in the world we are witnessing the consolidation of large production units of capitalist type making massive use of non-agricultural resources, most notably extra-familial capital, often focused on exports, although as yet the phenomenon involves only a limited number of entities (cf. figure 6). Such large-scale farmers and the enlargement of holdings are frequently associated with technical progress, mechanization, implementation of the technical packages of the "Green Revolution" and the productivity gains necessary to "feed the world"[20]. But for many they also symbolize the problems intrinsic to globalization: deforestation in Indonesia, land grabs in African countries, the destructuring of rural areas in Latin America, and so on.

Overall, corporate farming will strengthen a certain form of globalization – the globalization of multinational corporations upstream in agriculture, agro-exports and large retail chains. Without it, the global food system would find it difficult to reconfigure itself along the lines of the global value chain model promoted by the industrial sectors. Globalization runs counter in this case to the long-term survival of small family farms, despite the fact that demographically the latter are still in the majority.

17. Baret P., Vanloqueren G., 2009, "How agricultural research systems shape a technological regime that develops genetic engineering but locks out agroecological innovation", *Research policy*, 38, 6, pp.971-983.
18. Pickett J.A., Woodcock C.M., Midega C.A. et Khan Z.R., 2014, "Push-pull farming systems", *Curr Opin Biotechnol.*, 26, pp.125-32.
19. Hervieu B., Purseigle F., 2013, *Sociologie des mondes agricoles*, A. Colin.
20. Griffon M., 2006, *Nourrir la planète. Pour une révolution doublement verte*, Odile Jacob.

Figure 6: **Breakdown of holdings by size**



NB: The graphic on the left breaks down holdings by size interval. The graphic on the right breaks down areas. For example, in China, 93% of farms are less than a hectare in area. Those farms represent 73% of areas. In Europe, 1.7% of holdings are over 100 hectares in area and account for 39% of all areas.
Source: *MOND'Alim 2030*, page 94, based on J.-F. Bélières *et al.*, CIRAD

At the present time the debate surrounding desirable production models is polarized around issues of environment, land and access to international markets. However, the divisions between modes of production (green revolution / agroecology) on the one hand and, on the other, production entities (small farms / large farms; family farming / corporate farming), are far from congruent. The promoters of family farming tend to assimilate it to agroecological modes of production but behind this generalized label "family farms are characterized by a wide variety of technical systems ranging from agroforestry to specialist single crop farming making massive use of chemical inputs, and including no-till and integrated farming"[21]. It may also be noted that the ways in which work and the factors of production are organized are highly diverse, as are the forms of local integration and relationships with markets. Some small farmers may be integrated into global markets while others may be highly marginalized. The alignment or, conversely, the overcoming of such divisions will be a major issue for food system actors in 2030.

"Contract farming" is becoming the preferred approach to value chain organization. Reference to contractual specifications is intended to establish a degree of trust between the links in the chain and with consumers in spite of geographical distance and information asymmetry. In the future, the development of precision agriculture, allowing every operation on the crop to be tracked, could move in the direction of sector contracts that will reduce even further the room for manoeuvre of farmers in relation to their corporate partners[22]. In their use of distributor's brands, some agrifood and retail firms are taking this product control logic further by assimilating the upstream portion of their agricultural supply chain. Unequal contractual relationships are characteristic of a form of globalization driven by large-scale actors that determine an approach and impose it on less powerful actors.

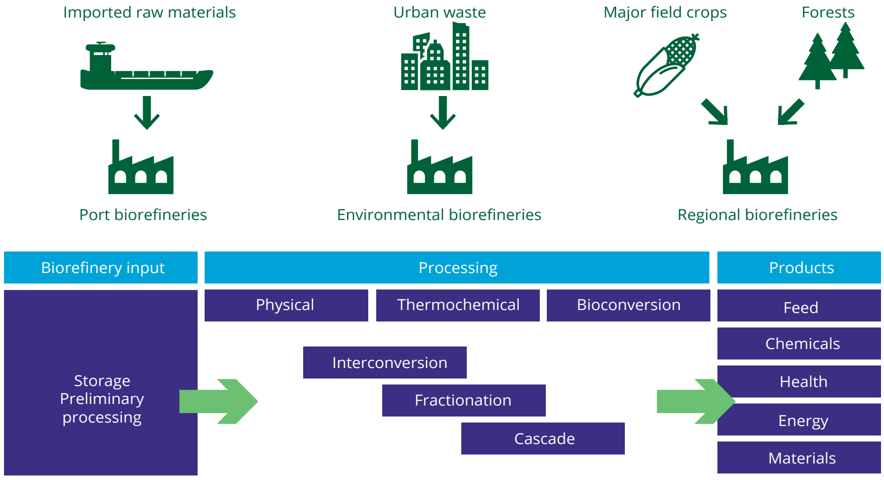
But once again, the situation is far from uniform around the world and other organizational models will coexist or be in mutual competition in 2030: cooperative strategies and direct selling, for example. Organizational modes will adjust to globalization in each country in accordance with its past history and its resources. Some producers are for example going down the road of direct international sales, and the wine sector is often the reference in this context. The development of farmers' markets in the United States, AMAPs in France and *teikei* in Japan reflect an aspiration on the part of some consumers for simpler supply chains and fewer intermediaries for a better apportionment of added value. By 2030, this desire to relocalize or re-personalize commercial relationships will have been strengthened by the development of international commercial platforms on the Internet.

Lastly, the bioeconomy, an expanding industrial paradigm, also introduces new ways of seeing supply chains with the objective of making use of biomass through a systemic approach "constructed around platform molecules (multi-use, reusable) and a series of physical and chemical procedures"[23]. This makes food products just one more category of co-product (materials, pharmaceuticals, energy, etc.). But its development will not be smooth. In the 2000s, biofuels were already being accused of competing with food crops. The bioeconomy could also reinforce an operational division between countries positioned "at the top of the global value chain" and "cheap biomass producers" driven to "degrade their natural resources by excessively intensive use"[24]. The bioeconomy is compatible with both a very advanced form of globalization (port biorefineries), like the petrochemicals industry, and a regional re-embedding of biomass flows (cf. figure 7). The forms of globalization will differ according to the solutions prioritized in the years to come.

3.3. Local/global: Internet and social media facilitate quantum leaps in scale

In the media, each new topic is pushed out by the next and the treatment given to sanitary crises feeds into a collective public awareness of globalization but one that is no more than ephemeral and patchy. Moreover, censorship and disinformation exist at various levels, local, national and international. For example, in the contaminated milk affair in China in 2008, the Chinese search engine Baidu is suspected of having purged users' search hits of all adverse information concerning the Sanlu brand implicated in the scandal[25]. In the area of gastronomy and food and wine tasting, copious, fragmentary information difficult to grade or validate helps ensure the success of various prescribers and opinion leaders such as Robert Parker, the celebrated Wine Spectator critic. This proliferation of poorly controlled, unstructured information of uneven quality feeds into a theme of shady globalization orchestrated by the big multinational corporations. The rhetorical figure of the "revelation" and accusations of lobbying and conspiracies are thus omnipresent in the alter-globalization movement.

Figure 7: **The bioeconomy's three domains**



Source: *MOND'Alim 2030*, page 97, after Colonna F. *et al.*, 2015

21. Belières J.-F. *et al.*, 2013, *Les agricultures familiales du monde. Définitions, contributions et politiques publiques*, CIRAD report for the French Development Agency (AFD), the Ministry of Foreign Affairs and the Ministry of Agriculture and Food, http://www.cirad.fr/publications-ressources/edition/etudes-et-documents/les-agricultures-familiales-dumonde.

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Faced with this unreliability in information and the fragmentation of public spaces, some actors provide issues with a degree of continuity for public opinion. Investigative journalists, NGOs, whistleblowers and activist researchers all provide alternative expert views on topics such as GMOs and international land investment. New methods for activism call into question the boundaries between information and action, between protest and entertainment[26]. Various media are exploited: pages on social media, YouTube tutorials, encounters linked to documentaries, and so on. Activist networks make local struggles and specific cases into symbols of universal combats and offer visions of the world that propose "alternatives" that run counter to a "dominant model".

Some of these actors specialize in highly emotive media campaigns. Greenpeace for example has set up a "mobilization lab" for the dissemination of know-how for direct action. This NGO played a driving role in raising awareness in Europe of the deforestation problems linked to soybeans (Brazil) and the development of oil palm plantations (Indonesia). Sophisticated storytelling techniques raise the awareness of consumers in developed countries to far-distant situations with which, often unknown to themselves, they are in fact linked *via* long chains of intermediaries (cf. figure 8). Those actors are weaving, as a counter to the harm done by the globalization they accuse, the fabric of an emotional, informational globalization of "just causes".

*

The processes globalizing food systems are becoming deeper and more marked with turnkey supply of reinterpretations and reappropriations of old solutions by multinational companies both upstream and downstream in the agricultural supply chain. The world of 2030 will therefore be characterized by a consolidation of sets of referential criteria – a trend linked to the crucial role of multinationals in the innovation regime that dominates worldwide[27] – but also by a hybridization of currently antagonistic logics.

Certain innovations will play driving roles: logistics, connected agricultural equipment, biotechnology, among others. ICTs will enable inventions to be rapidly disseminated and included in new value chains, in addition to building networks of local actors promoting alternative models. These technologies will be a response to the global challenges of resource preservation and food security. But they will also be capable of contributing to the concentration of knowledge and its privatization. Technological innovations will therefore be vehicles for both opportunities and threats for food systems.

There will be similar ambivalence in the power relationships surrounding control of more globalized food systems. Actors from the fine chemicals industry, energy, the digital economy, initially strangers to the agrifood sector, will be protagonists in these radical changes. "Big data" brings with it an emerging scenario whereby the actors of the Silicon Valley will take over from the major agrifood and retail brands and redefine global standards and consumption modes. Some, like Google, have clearly asserted their vision of a sustainable food system and are actively working to bring it about. But in many cases the roll-out of the most effective innovations can take years and the simultaneous generalization of the trends we identify seems unlikely over the period to 2030.

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Figure 8: **Greenpeace and the combat against deforestation – the 2010 campaign**

Source: *MOND'Alim 2030*, page 83; images taken from the Greenpeace France website; treatment by the authors

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