Sustainable, circular and collaborative business models to facilitate the transition to the circular economy with the framework

BM3C2

Practical Case

Isocycling horticultural Plastic Films

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Preliminary remark

All practical cases are based on real cases in which we have actually been involved. We have chosen them for their diversity and for the amount of data we have at our disposal, in order to propose pedagogical cases that are as close as possible to reality.

They have been anonymized.

Indeed, organizations are constantly evolving and the cases proposed here show their situation at the time of their study, which will be different a few months or years later.

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Context

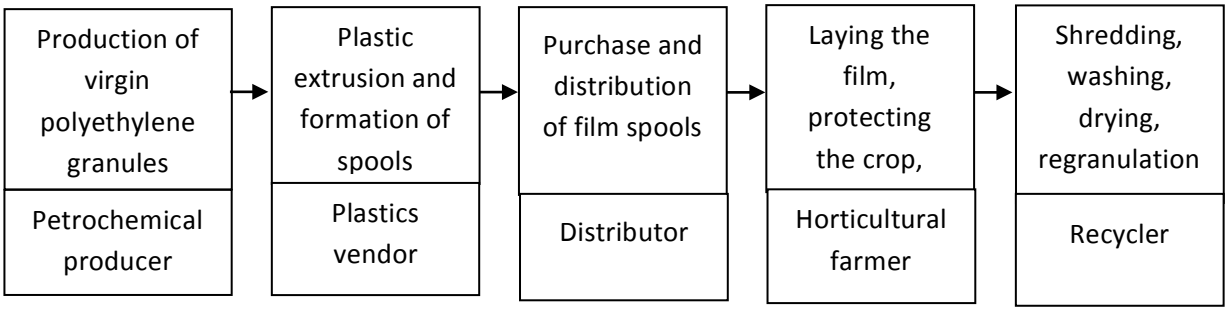
Plastic film, an essential input in horticultural farming in the Nantes region

Geographically speaking, the region of Nantes (France) offers favorable conditions for horticultural farming: a mild climate, plenty of water from the nearby Loire river and sandy soils conducive to the growing of vegetables. In 2016, a total of 210 horticultural farms cultivated approximately 30 plant species, employed 4,000 full-time workers, and had a turnover of 300 million Euros. With 30,000 to 35,000 tonnes produced per year, the flagship product, lamb's lettuce, accounts for 85% of national production and 50% of European production. The specialty of the horticultural farmers of Nantes is the production of fresh vegetables. Available on the market in early spring, they can be sold at a good price because they are still scarce. Two techniques enable farmers to obtain early produce. First, crop is cultivated on planks within mounds of sand to avoid water stagnation which is harmful to vegetables. From the end of September to the end of March, the planks are then covered to protect seedlings and young shoots from bad weather and diseases, and to accelerate their growth. Today, the small semi-forcing tunnel known as the "Nantes tunnel" is the type of coverage most commonly used and it consists of a polyethylene film stretched over the tunnels' arches. This film must allow light to pass through to enable the photosynthesis indispensable to the growth of the vegetables and must also be very resistant to avoid tearing during its mechanical installation and removal, or in the event of a storm.

The life cycle of horticultural plastic films

The life cycle of plastic films follows a linear path with five main phases and actors (Figure 1).

Figure 1. The current life cycle of horticultural plastic films



Petrochemical companies produce virgin polyethylene pellets primarily from petroleum compounds. However, few suppliers can provide granules to produce films highly resistant to tearing. Moreover, the price of virgin pellets is the single largest component of the cost of producing plastic spools. Plastics companies extrude these pellets to obtain plastic films that are then wound onto spools. To ensure mechanical resistance, semi-forcing films are composed of three layers. The central layer forms half the total thickness and the polyethylene recipe used in this layer differs from that used in the two peripheral layers. The film spools are delivered to distributors on pallets. Each horticultural farmer buys, via his/her cooperative or producer organization, several hundred spools annually. The purchase of film spools is often the third largest expense item for horticultural farmers, amounting to some tens of thousands of Euros. The films are placed in "horticultural plots" with a tractor and an unwinder and used once, for a duration ranging from three to ten weeks[1]. Two or three crop cycles can be planted successively on the same plot during the winter. When the films are removed just before harvest, they are covered with water (rain, dew, and frost), sand, and soil. The stains cover two thirds of the entire mass of used films! Since the ban on the burning or burying of the used plastic films used by horticultural farmers in the early 1990s, these films are recycled in a factory near the farmers, at Landemont in the Maine-et-Loire region. The used films delivered are weighed, shredded and washed before being regranulated. Second-generation pellets are used to make garbage bags and tarpaulins. Other than the horticultural industry, this outlet involves the downcycling of films with high mechanical properties.

The collaborative SMART[2] project (Table 1), led by the company AgriPlast in Pouancé (Maine-et-Loire), seeks to "isocycle"[3] these films so that they can be re-used. Although the

[1] The installation/removal of semi-forcing tunnels is part of the 8 main activities of horticultural gardening: supply (seeds, sand, semi-forcing film), seedlings, *laying tunnels,* management and maintenance of horticultural holdings, *removal of the tunnels,* harvesting vegetables, inspection and sorting, washing, packaging and dispatch.

[2] *Sustainability, Material, Agreement, Recycling, Together.* Collaborative project certified by the Végépolys competitiveness cluster (specializing in plants) and financed by the Pays de la Loire Region.

semi-forcing and mulching films in AgriPlast's horticultural range account for only 10% of its turnover, its installation in Pouancé is due to the fact that its revenue is generated primarily from the sale of wrapping and silage films which find important outlets in agricultural activities (cultivation and animal husbandry) in Normandy, Brittany, Pays de la Loire and Poitou, i.e., the regions close to Maine-et-Loire. AgriPlast has industrial equipment to produce new films but also has recycling lines for used plastic, mainly from industrial sources. The SMART project paves the way for a circular economy with new business models and new value propositions. However, it must take into account the fact that there is a national system charged with collecting and adding value to used agricultural films.

Table 1. The partners of the SMART project

Partner	**Status**
AgriPlast (Project manager)	Producer/recycler of plastic films
SCEA B. Brothers	Horticultural farmer, FMN administrator
FMN (Federation of the Horticultural Farmers of Nantes)	Agricultural union of horticultural farmers
CDDM (Departmental Committee for the Development of Horticultural Farming)	Technical support center for horticultural farmers
IPM (Horticultural Farmers Innovations and Prospectives)	Strategic management of the horticultural farmers sector
AgroCampus Ouest Angers	School of Engineering (agronomy).Research
University of Nantes	Higher education. Research

[3] "isocycle": neologism meaning same function, same as value or same quality after second use or recycling by opposition to "downcycling" (lower function/value/quality) and "upcycling" (improved function/value/quality).

The organization of recycling used agricultural films

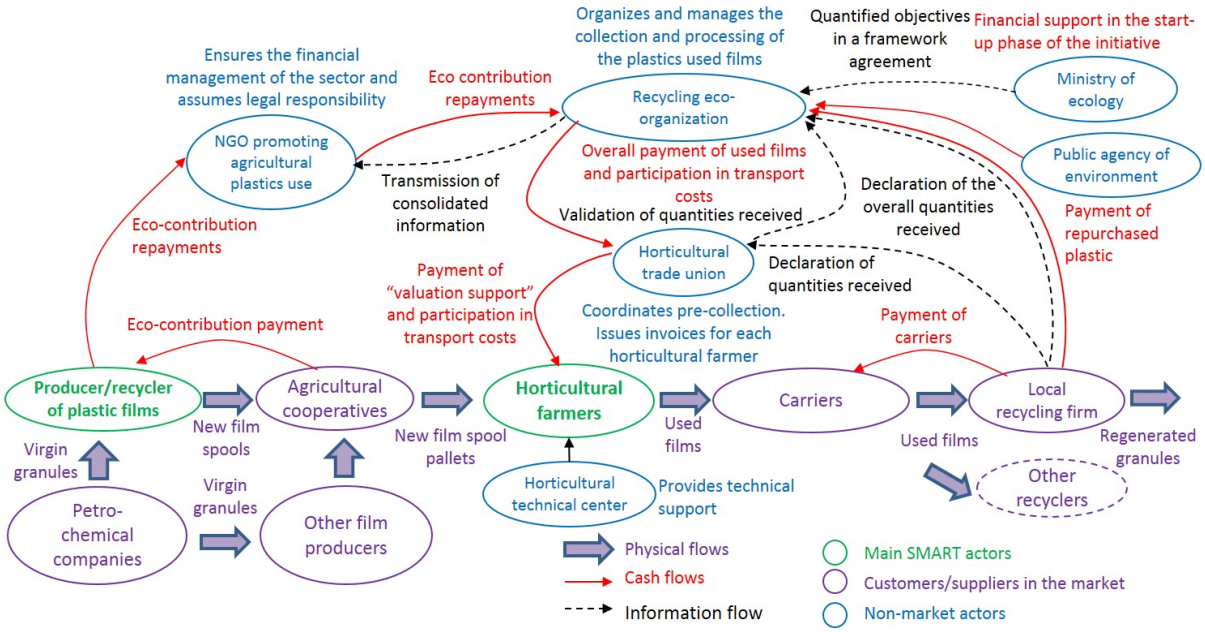
Low-density polyethylene (LDP) is the constituent material of horticultural films and many other packaging products. The low recycling rate of this resin (15%), at the national level, may be explained by the difficulties plastics vendors and recyclers encounter. The quality of inputs is extremely heterogeneous, raising the costs of recycling and making the process more complex. This also makes the provision of stable outputs problematic. The price of recycled pellets follows the fluctuations in price of virgin pellets, generally at a discount. However, the price of virgin pellets is directly related to the speculative oil market. This can cause supply difficulties for companies specialized in plastic processing. Moreover, the cost of pre-processing used plastics (collection, sorting, washing, etc.) may exceed the price at which recycled plastics are sold if oil prices are low. Until recently, solutions such as exporting to China were preferred to recycling because they were an easier and cheaper solution. Often, only cost-compensating mechanisms, through contributions under the "Extended Producer Responsibility" principle, help restore the financial equilibrium of recycling chains. The eco-contribution mechanism is applied to used agricultural films (UAF) managed by the Agriculture, Plastics and Environment (APE) initiative.

The APE initiative (Figure 2) was set up following the recommendations of the CPA (French National Committee for Plastics in Agriculture)[4]. Government authorities adopted the principle in 2006 and professionals in the sector participate on a voluntary basis. The CPA entrusted A.D.I.VALOR[5] with the management of the APE initiative. Since 2009, A.D.I.VALOR has been organizing and financing the collection and processing of used agricultural films. Framework agreements with the State set the objectives to be achieved. The second agreement, signed in 2011 with the Ministry of Ecology, set out to collect 75% of used films and to recycle 99% of agricultural films by 2015. ADEME provided financial assistance to A.D.I.VALOR from 2009 to 2012 to support the initiation of the venture. It was then expected to be funded by the collection of an eco-contribution which would be added to the price of each spool put on the market. Used films are bought from horticultural farmers at a price set by A.D.I.VALOR and referred to as "value addition support". The FMN (Federation of the Horticultural Farmers of Nantes) provides the interface between its members and A.D.I.VALOR. Although the amount of collected eco-contributions for semi-forcing films has steadily increased, rising from 25 Euros/t in 2009 to 80 Euros/t at the end of 2014, this amount is still insufficient to cover operating costs. Reducing the soiling rate of the films would enable financial equilibrium to be achieved because it reduces the costs associated with their processing.

[4] Founded in 1958, the CPA is an association which seeks to promote the development of plastic applications in the agricultural sector.

[5] A.D.I.VALOR (Farmers, Distributors, Manufacturers for the Valorisation of agricultural waste) is an eco-organization founded in 2001 to manage the collection and disposal of agricultural waste whose list of activities has progressively lengthened over the years (empty packaging, plant protection products, twines and nets, etc.).

Figure 2. The life cycle of plastic horticultural films and the APE initiative



The project

Towards a recycling of used horticultural plastic films

In addition to taking into account the context described, the SMART project must address three obstacles: 1) the feasibility of producing recycled film from used and soiled horticultural films, 2) maintaining the mechanical and agronomic performance of recycled films (tear resistance, crop quality and returns), and 3) the social and technical management of the transition to a circular economy.

To overcome the first obstacle, AgriPlast collects used films from the horticultural farmers participating in the project to recycle them. The pellets obtained are of good quality but the operation is difficult and costly. Indeed, the washing lines are designed for used films originating from industrial sources, which are much less soiled than horticultural films. In a series of test films, recycled granules are then incorporated, with rates ranging from 10% to 100%, in the central layer; peripheral layers remain exclusively composed of virgin resins. Qualification tests show that the mechanical properties of these recycled films are equivalent to those of new films. These control films are placed in a plot of a horticultural farmer participating in the project in order to observe them in real conditions. The CDDM (Horticultural Farmers' Departmental Development Committee), a partner of the SMART project, also carries out tests to determine the agronomic performance of the films. The tests have shown that these films perform just as well as new films in terms of performance, transparency and ease of installation/removal. Interviews were conducted with horticultural

farmers to address the third obstacle, and to probe in particular their acceptability of recycled films and the business models of the circular economy. The horticultural farmers are ready to use recycled films provided that their resistance and transparency are guaranteed, and that they are cheaper or, at worst, the same price as new films. However, they have more reservations with regard to the business models of the circular economy. They consider that a semi-forcing film is a disposable single-use product. Every year they are used to pitting plastic suppliers against each other to buy the cheapest possible spools. Consequently, they do not fully understand the idea of being charged for a use that, from their point of view, will be more expensive than buying a new product. They are also reluctant to engage in a long-term contract with a single supplier while they themselves are unsure of their activity's future, even in the short term, given the weather and market risks. Moreover, there are two sticking points between horticultural farmers and plastic suppliers. First, farmers consider their films to be clean, compared to mulching films for instance, but plastic suppliers consider them to be very dirty compared to used films from industrial sources. Today, horticultural farmers even consider that their used films are a co-product of their activity that they must put to the best use possible. Second, noting that there is no correlation between the price of films and the oil prices which still largely determine the price of films, farmers have come to the conclusion that these prices are opaque. This has made them suspicious and has encouraged them to try and maintain control of their films in order to put them to the best use possible.

To circumvent the limits of its means of production in the short term, AgriPlast has outsourced the washing of used horticultural films and their regranulation to a service provider experienced in processing dirty films. The recycled pellets obtained are of good quality and cost less than the internal cost. To overcome the third obstacle, the partners of the SMART project have decided to organize a meeting to discuss and compare the different viewpoints between horticultural farmers and plastic suppliers in order to envision solutions acceptable to each party. This meeting has already been cancelled twice by the farmers, who have stressed that their farms are their priority. After taking stock of the situation, AgriPlast has decided to launch a new product line called Triosmart. The Triosmart film has a central layer composed of 100% recycled pellets originating from used films from industrial sources. This range is sold exclusively to horticultural farmers, conventionally and at the same price as new film. After use, this film is recovered by AgriPlast, which washes and regranulates it through its service provider. Using the regenerated pellets, AgriPlast then produces a second-generation film that becomes, after a winter spent in horticultural plots, a film of agricultural rather than industrial origin. With the commercialization of the new film, AgriPlast has deepened its understanding of user expectations and the positioning of the product in the Nantes market. The difficulties encountered have been revealing and have helped AgriPlast become aware of its key skills and thus how they can be reinforced. AgriPlast has thus consolidated its expertise in adding value to used films originating from industrial sources, which allows the company to produce "high performance recycled plastic". This emerging skill is intended to generate a competitive advantage or even create a new activity for AgriPlast. The company thus hopes to become a major supplier to the horticultural farmers of the Nantes region because of the quality of its products and the services it will provide them with: attentiveness to their needs through the regular presence of the sales agent on the ground, who relays information to the R&D department, rapid deliveries, and rapid response

times to farmers' difficulties. AgriPlast's geographical proximity to horticultural farmers (75 km versus 700 km for its main competitors) ensures a quality relationship and has enabled it to gain farmers' trust.

Lowering the costs of the Triosmart film to below those of new film would require greater proximity to horticultural farmers and plastic suppliers, specifically in terms of cognitive and organizational proximity. The unknown factors associated with the transition to a circular economy should strengthen the sharing of information. While it was easy to improve the technical performance of films, economic and financial data have remained confidential. AgriPlast is not inclined to disclose its cost structure, which varies according to fluctuations in the price of virgin pellets. By pitting plastic suppliers against each other to buy the cheapest spools possible each year, horticultural farmers prevent the reaching of a medium to long-term agreement to recover the investments made (for instance a more efficient washing line) and to ensure a steady flow of plastic to be recycled, in terms of both quantity and quality. Progress towards truly circular business models is thus hindered.