



INTEGRATED PEST MANAGEMENT AS MEASURE OF ADAPTATION: BIODEGRADABLE MULCH FILM

TECHNOLOGY DESCRIPTION

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The spread of atypical or rapid development of typical pests, weeds, and diseases are harmful climate change consequences for agriculture. Chemical plant protection products (PPPs or pesticides) have fast but extremely short-term efficiency due to increased resistance to their action. PPPs impose a severe negative impact on human health and the environment. PPP application may be a sensitive issue due to trading regulations corresponding with climate change policies such as Green Deal implementations or pandemic restrictions. In this regard, the interest in mulching fields with biodegradable films, not only for thermoregulation purposes, is increasing. Biodegradable film (BF) is made from organic components of plant and animal origin. Therefore, it can be destroyed by chemical reactions under the influence of microorganisms, the sun, and oxygen. It decomposes into water and carbon dioxide, and is absorbed by soil microorganisms, becoming one of the organic soil matter components. Decomposition and biodegradation occur by the biological action of living microorganisms that naturally exist in any ecosystem.

According to its technical characteristics, the film can have an average thickness from 8 to 80 microns, which directly affects its lifetime (3 to 24 months), and has a width of 50 to 280 cm. Available types of film - transparent, black, and colored - have different techniques and species designations. BF can be stacked either using a particular film-laying machine or manually. Biodegradable mulch film (BMF) does not require significant changes in technological maps. The biodegradable film is laid during sowing. For a large amount of cultivated area, it is advisable to purchase specialized equipment such as a bed-maker and mulching film layer (as is used in mulching with conventional plastics). However, in relatively small-scale areas, mulching with BF can be performed using standard seeding equipment. Therefore, it does not entail high costs for the design, production, and purchase of new sowing machines for BMF processing, making this technology affordable for the majority of farmers. Moreover, BMF may be suitable for use in all agro-climatic zones of Ukraine, especially zones with a soil moisture deficit for agriculture, horticulture and orchards. However, BMF application is most efficient for vegetable production in general and particularly for tomatoes. Tomatoes are the leading vegetable crop in the world. However, during the recent decade, a significant shortage of tomato production has been observed in Ukraine. The analysis of time series data of the cultivated land under vegetables from 2010 - 2019 showed that the most significant shortage occurred in the area under tomato production (-14.9 thousand ha), the second and third place under the cabbage (12,5 thousand ha) and onion (12 thousand ha), correspondingly.

In addition to the limited size of the vegetable processing sector in Ukraine, unfavorable weather conditions have also accelerated reductions in vegetable cultivation. Constant weather changes contribute to the spread of disease and adversely affect the yield. Moreover, developing carbon adjustment mechanisms under Green Deal requirements or other trading regulations occurring with environmental protection may negatively affect further vegetable production in Ukraine.

In this regard, the application of BMF has a set of direct and indirect benefits which provide an opportunity to increase vegetable production under climate change in general and tomato growing specifically, making BFM one of the priority adaptation measures for agriculture.

A more detailed description of technology implementation is provided in [Barriers Analysis and Enabling Frameworks](#).

CURRENT TECHNOLOGY READINESS LEVEL OR COMMERCIAL READINESS INDEX



Globally, the intensive growth of the biodegradable mulch film market has been observed in recent years in North America and West Europe.

North American countries such as the U.S. and Canada have enormous potential to drive the growth of the biodegradable mulch film market because these countries have adopted the world's best cultivation techniques. In Western Europe, the development of the biodegradable mulch film market increased by 7% from 2019 to 2020. The Ukrainian market is anticipated to follow trends similar to the European market because Ukrainian agriculture producers are export-oriented into the EU. Currently, the primary demand for BFM is in the south of the country by horticulture and vegetable producers. Moreover, more than 90 percent of vegetables are grown by peasant households with an average land bank size of around 2 hectares. Considering the harvested area under vegetables it can be argued that around 35,000 – 200,000 peasant households may be potentially interested in using the technology.

The more difficult task is to assess the development over time due to the limited supply of BMF in the national market and comparatively low interest in developing this technology. Analyzing the available offers from service providers on BMF, we can assume that currently they could cover up to 15 percent of the demand described above. The national supply is sourced from several BMF producers, both international and national. For example, the global company Ginegar manufactures Mulch More BFFs, which has a slightly lower price for those of similar quality. The national BMFs are produced by the joint company IMMER Group (IMMER Ukrplastic, IMMER Digital, and IMMER Design Studio). The IMMER Group provides an entire manufacturing cycle of flexible packaging materials and uses a wide variety of crop production technologies.

The current equilibrium in the BF market is caused by the slow growth of demand. In case of more active advertisement and under increasing interest from farmers for BFM, farmers will face with a lack of BF and a competitively high cost. To satisfy the growing needs, the development of domestic production of BF and increasing the potential to produce feedstocks for BF production are required. Regarding the current level of BMF technologies and increasing regulation on conventional plastic usage, the Technological Action Plan implementation might take about seven years (by 2028) to set up necessary activates and develop enough potential to cover about 90 percent of expected demand

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CLIMATE RATIONALE OF THE TECHNOLOGY

A well-known fact is that keeping soil moisture and combating drought will be the key factors in adopting Ukrainian agriculture to climate change. However, the another, less popular for discussion but not less dangerous climate change consequences for agriculture is massive and uncontrol spreading both typical and untypical diesis and pests. Traditional agro producers in Ukraine apply chemical pest control. Though the problem is that often, farmers use low-quality pesticides in a not relatable way. This brings to increasing production cost while the efficiency is still low, soil and water contamination, lost biodiversity, and, as a result, decreasing the ecosystem resilience to climate change and their ability to adapt.

Biodegradable mulch film helps to adapt crop production due to thermal regulation, water retention, preventing weed growth, curbing soil contamination, maintaining soil nutrition, heat preservation, soil temperature increases (where required), and photosynthesis improvement. Applying BMF contributes to improving the eco-system balance and increasing the natural resilience through decreasing the chemical pest intervention.

One of the critical consequences of climate change is changing the agro-climatic zones and unstable and abnormal production cycles for farmers. The application of BMF allows for stabilizing seasonal variations and aligning the sowing times.



Moreover, BMF technology is a win-win measure that positively impacts policy on climate change maintenance utilizing carbon emission reduction and sequestration due to reduction of direct soil disturbing and decreasing chemical pesticides application.

AMBITION OF THE TECHNOLOGY

SCALE FOR IMPLEMENTATION AND TIMELINE

BMF technology is competitive with other adaptation measures as its production is business-oriented and affordable for a wide range of users. Ambitions for TAP could be mainly defined by the potential capacity of market, multiplying by the trend of technological development and price forecasting.

Based on the trend of horticulture and vegetable production development in Ukraine, it might be estimated that technology can be disseminated among the 100 thousand farmers (vegetable producers) for the next seven years by 2028 and would cover around 180 thousand hectares mainly concentrated in Kherson, Mykolaiv, and Lviv oblasts. For this purpose, at least a BMF manufacturing plant might be established to satisfy the market's increasing demand.

EXPECTED IMPACTS OF THE TECHNOLOGY

As mentioned above, the BMF technology has a set of climate rational advantages that increase agricultural resilience to climate change, reduce the environmental load, and decrease carbon emissions and soil and water contamination.

However, the most valuable aspect for farmers is the economic efficiency of the BMF application. The economic efficiency could stimulate them to widely apply BMF in Ukraine without other state support for small and medium-scale farming. From this perspective, applying BMF allows an increase in yield by an average of 30% for all crops, and for some of them up to 75%; a reduction in costs for water, fertilizers, and PPP up to 40% for all crops, and for some by three times; finally, an increase in the export potential of agricultural products through quality improvement.

Profitability received from BMF application for vegetable production is even higher than profitability obtained from production in greenhouses. At the same time, BMF technology costs almost two times less than greenhouse production or traditional cropping with PPP application. Increasing BMF application might stabilize further growth of vegetable production, particularly tomatoes and watermelons. It is an important segment that is the source of wellness and livelihood for thousands of small farmers in the south.

Moreover, the application of BMF provides long-lasting positive social effects. First of all, the relatively low cost makes BMF affordable for many farmers, including households and small-scale farmers. On the one hand, small-sized farmers are the most numerous group of agro producers counts around 30 thousand. It is the core of agriculture and rural life. On the other hand, they are the most vulnerable to climate change consequences with limit capacity for adaptation.

Secondly, the technology application is equally available for all social groups, including women, youth, and does not depend on the education level. Thus, rural women who run small households can afford the BMF application

On the other hand, their significant share of small households is managed by rural women. Thus applying BMF is toward inequality equalization.

POLICY ACTIONS FOR TECHNOLOGY IMPLEMENTATION

EXISTING POLICIES IN RELATION TO THE TECHNOLOGY



One of the causes of low interest in BMF technology is the lack of understanding of the harmful consequences of plastic application and usage of fossil-based materials in horticulture by governmental representatives and producers. In this regard, the recently adopted Law of Ukraine 'On the restriction of circulation of plastic packages in the territory of Ukraine' should reduce plastic production and regulation of its circulation and finally focus attention on the problem. Besides, strengthening legislation capacity on waste management and environmental protection pushes farmers to pay more for green production solutions. For more prominent export-oriented producers, applying BMF is a way to reach requirements defined under the Green Deal and national commitments referring to climate change. Finally, the government has described vegetable production as one of the priorities for agriculture and launched the State target program of vegetable growing for the period till 2025.

Besides inevitable regulation and legislation initiatives, Ukraine has a solid institutional potential to launch research and test different types of bioplastics and their impact on agriculture production. The Academy of Agrarian Science of Ukraine consists of 164 research state enterprises and can cover the complete set of such studies with a further recommendation.

Different studies show that small and medium-sized farmers' most reliable knowledge sources are big-sized and successful agro-producers, other farmers, or input provider consultants. There are 140 agro-holdings in Ukraine. They are leading in the agricultural market of Ukraine in terms of technology transfer and implementation. Thus, agro-holdings can develop a circular economy and both produce BMF and supply it. This is in line with the Strategy of economic development by 2030 which envisaged support in creating the research productions clusters. Developing clusters on the base of agro-holdings could be an excellent base for launching the biotechnology sector in Ukraine, including BMF.

PROPOSED POLICIES TO ENHANCE TECHNOLOGY IMPLEMENTATION

They are three core directions of policy development that might be distinguished to enhance the technology implementation: (i) strengthening regulations on the application of conventional plastic films and chemical pesticides; (ii) increasing technological capacity for BMF production and dissemination; (iii) stimulating demand for integrated pest management, including BMF technology.

Following these directions, the Technology Action Plan incorporates feasible measures able to stimulate the institutional potential and market chain (demand- supply) for BMF in the comparatively short term of seven years:

- To improve the existing environmental national legislation (The Amendment Law of Ukraine on environmental protection) to increase responsibility and control on fossil-based plastic film disposal.
- To facilitate the development of the National Strategy on bioeconomy/circular economy in Ukraine
- To initiate changes in the tax system and support payments for accelerating bio-based plastic film production and agriculture application.
- To conduct national studies of cost-benefit analysis that compare different pest control technologies with a focus on the ecosystem services based on life cycle assessment by agro-climatic zones.

COSTS RELATED TO THE IMPLEMENTATION OF POLICIES

Considering the capital cost of creating a new type of manufacturing in Ukraine, the approximate cost of implementing priority measures to stimulate BMF wide dissemination and achieve the target in 180 thousand hectares lies between 12-22 million USD by 2028. This amount includes the expenses on:

- Adjusting the national environmental and financial regulation and enhancing the environmental policy - 1- 5 percent from the total budget.



- Increasing the technological capacity to improve supply - 98 - 95 percent of the total budget.
- Gaining the research and practice-based knowledge - 1-3 percent from the total budget.

USEFUL INFORMATION

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LINKS TO TNA REPORTS

Report	Year	Link
TECHNOLOGY ACTION PLAN. ADAPTATION. UKRAINE (in progress)	2021	https://tech-action.unepdtu.org/country/ukraine/
BARRIER ANALYSIS AND ENABLING, FRAMEWORK REPORT. ADAPTATION.UKRAINE	2020	https://rb.gy/atwsg4
TECHNOLOGY NEEDS ASSESSMENT REPORT ADAPTATION. UKRAINE	2019	https://rb.gy/wx7fzs