



Technical University of Moldova

**INCREASING THE COMPETITIVENESS OF
THE MOLDOVAN APPLE SECTOR
THROUGH THE IMPLEMENTATION OF
HARVISTA TECHNOLOGY**

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ANNOTATION
to the MBA Management in Agribusiness Microqualification thesis
developed by Leahu Viorel

The master's thesis is structured and includes: introduction, three chapters, conclusions and recommendations, bibliography and annexes.

Keywords: competitiveness, apple sector, pre-harvest quality management, 1-methylcyclopropene, Harvista, harvest window, firmness, export markets, technology adoption.

The field of study of the thesis is the competitiveness of horticultural export sectors and the contribution of pre-harvest quality management to it.

The purpose of the work is to determine whether, and under what conditions, the implementation of Harvista technology improves the competitiveness of Moldovan apple producers, and to establish the sector-level effect of wider adoption.

The objectives are to construct a theoretical framework linking pre-harvest quality management to competitiveness; to diagnose the structural constraints on the Moldovan apple sector; to analyse the technical results of commercial application at the Viorix-Agro enterprise on Gala and Red Delicious; to construct a partial budget and establish break-even conditions; and to model the effect of alternative adoption rates at sector level.

The scientific novelty and originality of the results obtained consist in: the first economic assessment of pre-harvest ethylene management under Moldovan conditions, conducted through a practical case study; the decomposition of the yield effect into retained fruit number and mass per fruit, which establishes that the dominant component is opposite on the two cultivars examined; the demonstration that the greater part of the benefit arises from the market specification the fruit is able to meet rather than from additional volume; and the quantification of the harvest window as the ratio between the picking days a crop requires and the days during which it remains within specification.

The theoretical importance of the work. The conclusions and recommendations formulated in this thesis contribute to consolidating the theoretical framework regarding the competitiveness of perishable horticultural exports, by establishing that competitiveness is a function of delivered quality rather than of quality at dispatch. The paper provides a rigorous foundation for the concepts of the harvest window, delivered firmness and specification compliance, and applies the Alchian–Allen theorem to explain why transport distance selects for quality, qualifying Porter's treatment of demand conditions for sectors whose producers sell ex-farm to exporters.

Applicative value. The proposed case study and quantitative analysis serve as a practical guide for producers, exporters, consultants and agricultural policymakers. The recommendations aim both at improving quality management at the enterprise level and at shaping institutional support, through a partnership for the independent testing of horticultural technologies, which can further contribute to the development of the fruit sector.

ADNOTARE

la teza de microcalificare MBA Management în agrobusiness

elaborată de formabilul Leahu Viorel

Lucrarea de masterat este structurată și cuprinde introducere, trei capitole, concluzii și recomandări, bibliografie și anexe.

Cuvinte-cheie: competitivitate, sectorul de producere a merelor, managementul calității înainte de recoltare, 1-metilciclopropană, Harvista, fereastră de recoltare, fermitate, piețe de export, adoptarea tehnologiei.

Domeniul de studiu al lucrării îl constituie competitivitatea sectorului horticola și contribuția managementului calității înainte de recoltare la aceasta.

Scopul lucrării este de a determina dacă și în ce condiții implementarea tehnologiei Harvista îmbunătățește competitivitatea producătorilor de mere din Republica Moldova, precum și de a stabili efectul la nivel de sector al unei adoptări pe scară largă.

Obiectivele lucrării sunt elaborarea unui cadru teoretic care corelează managementul calității înainte de recoltare cu competitivitatea; diagnosticarea constrângerilor structurale ale sectorului de producție a merelor din Republica Moldova; analizarea rezultatelor tehnice ale aplicării comerciale la întreprinderea Viorix-Agro pentru soiurile Gala și Red Delicious; elaborarea unui buget parțial și stabilirea condițiilor de prag de rentabilitate; precum și modelarea efectului unor rate alternative de adoptare la nivel de sector.

Noutatea științifică și originalitatea rezultatelor obținute constau în: prima evaluare economică a managementului etilenei înainte de recoltare în condițiile din Republica Moldova, realizată printr-un studiu de caz practic; descompunerea efectului asupra producției în numărul de fructe păstrate și masa per fruct, stabilindu-se că componenta dominantă diferă în funcție de soiul analizat; demonstrarea faptului că cea mai mare parte a beneficiului provine din specificațiile de piață pe care fructele le pot îndeplini, și nu din volumul suplimentar; precum și cuantificarea ferestrei de recoltare ca raport între zilele de recoltare necesare culturii și zilele în care aceasta rămâne în limitele specificațiilor.

Importanța teoretică a lucrării. Concluziile și recomandările formulate în această lucrare contribuie la consolidarea cadrului teoretic privind competitivitatea exporturilor de produse horticoale perisabile, stabilind că competitivitatea este o funcție a calității la livrare, mai degrabă decât a calității la expediere. Lucrarea oferă o bază riguroasă pentru conceptele de fereastră de recoltare, fermitate la livrare și conformitate cu specificațiile, aplicând teorema Alchian-Allen pentru a explica modul în care distanța de transport favorizează calitatea și nuanțând abordarea lui Porter privind condițiile cererii în cazul sectoarelor în care producătorii vând direct de la fermă către exportatori.

Valoarea aplicativă. Studiul de caz și analiza cantitativă propuse servesc drept ghid practic pentru producători, exportatori, consultanți și factorii de decizie din domeniul agricol. Recomandările vizează atât îmbunătățirea managementului calității la nivelul întreprinderii, cât și orientarea sprijinului instituțional, printr-un parteneriat pentru testarea independentă a tehnologiilor horticoale, demers ce poate contribui ulterior la dezvoltarea sectorului pomicol.

INTRODUCTION

The apple sector occupies an important position in the economy of the Republic of Moldova. Apples are the single largest fresh horticultural export by volume, they are grown across a large number of holdings of widely differing scale and technical level, and they support seasonal employment in rural districts where few alternatives exist. The sector is also, in a very direct sense, a barometer of the country's wider economic reorientation. For most of the post-Soviet period Moldovan apples were sold into a single market on terms that required little of the producer beyond volume. Russia absorbed the overwhelming majority of the crop, and the commercial logic of the sector – the cultivar mix, the grading standards, the packing formats, the payment terms – was organised around that fact.

That arrangement has been under intermittent pressure for two decades. Beginning in 2005, the Russian Federation imposed a succession of import restrictions on Moldovan fruit, applied and lifted on grounds that were widely understood to be political rather than phytosanitary. Each episode demonstrated the same lesson: a sector whose entire output depends on a single buyer holds no commercial position at all, only a permission that can be withdrawn. A minority of growers and exporters drew that lesson early and began looking for alternatives, and the first maritime shipments to Bangladesh and to the Gulf states were made in 2014. Volumes were small and the trade was exploratory rather than structural, but these consignments established that Moldovan fruit could physically reach distant markets and that buyers there would consider it.

The decisive break came with the Russian war in Ukraine from 2022. Beyond the trade restrictions themselves, the war compromised the overland transport corridors on which shipments from Moldova to Russia depended, so that the Russian market became not merely politically unreliable but logistically impracticable for much of the crop. Diversification ceased to be the strategy of a far-sighted minority and became a requirement for the sector as a whole.

What has followed is a period of accelerated market development. The European Union now absorbs a substantial share of redirected volume, and new destinations have been opened at considerable diplomatic and administrative cost: following trial consignments in 2023-2025 under phytosanitary supervision, the Republic of Moldova was approved for regular apple shipments to India in February 2025, while the exploratory Gulf trade of the previous decade has been built upon and South-East Asian markets have been tested. These destinations are attractive precisely because they are not the European wholesale market, where Moldovan fruit competes at the bottom of the price range against the volumes coming from Poland, the EU's largest and cheapest apple supplier [1]. They are also, however, markets that impose a requirement the Russian trade never

did. A consignment moving by sea to Mumbai or to the Gulf is in transit for something in the order of fifty to sixty days under normal routing, and rather longer where vessels are diverted away from the Red Sea and routed via Gibraltar. The fruit that arrives must still be firm enough to be sold at retail and consumed. Quality at the point of loading is therefore not a marketing preference but a technical precondition of market access.

Two further pressures act on the same point in the production cycle. The first is climatic. Moldovan growers increasingly report harvest seasons in which high temperatures in the weeks before picking compress and destabilise the harvest window, accelerating maturity and provoking pre-harvest fruit drop in susceptible cultivars before the crop can be taken off. The second is demographic. The seasonal labour pool available for hand harvesting has contracted sharply under the combined effect of emigration and rural depopulation, so that the number of pickings a grower can realistically organise, and the speed at which a block can be cleared, are now constrained by labour availability rather than by agronomic optimum. A grower facing a narrow harvest window and an insufficient crew must either pick early, sacrificing size, colour and soluble solids, or pick late and accept soft fruit and losses on the orchard floor.

On Gala these pressures take a specific and costly form. Gala is sold on colour, and a consignment that fails the colour specification is downgraded regardless of how it eats. The standard Moldovan picking window for the cultivar falls between roughly 20 August and 1 September, at which point the fruit is firm but frequently has not coloured adequately, because colour development in apple depends on warm sunny days followed by cool nights and late August in Moldova does not reliably supply the cool nights. Growers respond in the only way open to them: they wait. Every additional day on the tree in warm weather improves colour but advances the climacteric, so the fruit that finally satisfies the buyer's colour requirement has lost the firmness that the same buyer requires on arrival. The grower is thus obliged to trade one quality parameter against another, and the trade is made worse, not better, by the conditions that make waiting necessary. This is the concrete mechanism by which climate variability translates into lost value on one of the country's most important export cultivars.

These pressures converge on a single physiological process. Pre-harvest drop, accelerated softening and the loss of storage potential are not separate problems but three expressions of ethylene action in ripening fruit, and the colour-firmness trade-off is a consequence of the same process. This creates the possibility that a single management intervention, applied at the right moment before harvest, could address a constraint that is simultaneously agronomic, logistical and commercial. Harvista, a sprayable pre-harvest formulation of 1-methylcyclopropene, is such an intervention. It has been applied commercially in Moldova, including at Viorix-Agro, starting with

2024 but its economic effect under Moldovan conditions has not been documented in a form that would allow a grower, a lender or a policy-maker to evaluate it.

The research problem addressed by this thesis is therefore the following: the competitiveness of the Moldovan apple sector on distant, higher-value markets is constrained by the sector's ability to deliver fruit of sufficient residual firmness after extended transit, yet the harvest-management technology available to relieve that constraint has not been evaluated economically in the national context, leaving growers to decide on the basis of manufacturer literature and anecdote.

The aim of the thesis is to determine whether, and under what conditions, the implementation of Harvista technology improves the competitiveness of Moldovan apple producers, on the basis of commercial application data from Viorix-Agro, and to establish what the sector-level effect of wider adoption would be.

In order to achieve this aim, the following objectives are formulated:

- to establish a theoretical framework linking pre-harvest quality management to competitiveness in horticultural value chains, and to situate 1-methylcyclopropene within the set of harvest-management technologies available to growers;
- to diagnose the structural constraints on the competitiveness of the Moldovan apple sector, with particular attention to climate variability, seasonal labour scarcity and the quality thresholds imposed by distant markets;
- to analyse the technical results of the commercial application of Harvista at Viorix-Agro on Gala, where the objective was firmness retention, and on Red Delicious, where the objective was control of pre-harvest drop, against untreated control blocks;
- to construct a partial budget for Harvista application at the level of the hectare, and to establish the break-even conditions under which the treatment is economically justified;
- to model the effect of alternative adoption rates on the economic benefit obtained by growers and on the volume of premium-specification fruit available to exporters, and to identify the institutional and commercial preconditions for wider adoption.

These objectives correspond to three research questions. First, does pre-harvest 1-MCP application produce a measurable technical benefit under Moldovan orchard conditions, and of what magnitude? Second, is that benefit sufficient to cover the cost of the treatment, and how sensitive is the answer to fruit price and to the severity of the season? Third, what would the sector-level effect be if the technology were adopted more widely, and what would have to be true for that to happen?

Research methodology. The study follows a mixed-method design. The theoretical component is a synthesis of the international literature on agri-food competitiveness, on the physiology and field performance of ethylene-management compounds, and on technology adoption in agriculture. The empirical component has two strands. The principal one is a case study of the commercial application of Harvista at Viorix-Agro in the 2025 season, on Gala and on Red Delicious. On each cultivar a treated block was compared with an adjacent untreated control block of the same clone, rootstock, planting year and planting scheme: ten hectares against ten on Gala, and six against nine on Red Delicious. Because the harvest crew cannot work both blocks at once, the untreated block was picked when it entered the enterprise's premium firmness specification and the treated block as soon as that harvest was complete; the two were therefore harvested on different dates by design, and the effect of the treatment and the effect of the deferral it permits are reported together rather than separately. Monitoring covered flesh firmness at intervals on both blocks, pre-harvest drop counted on trees deliberately left unpicked, daily harvest volumes, and mean fruit weight determined on the grading line for the single date on which both blocks were picked. The second strand is a set of semi-structured interviews and field visits conducted by the author during the 2025 and 2026 seasons with other Moldovan growers using the technology. That material is observational rather than measured; it is not used to support any quantitative claim, and it informs the assessment of adoption conditions and the implementation roadmap. The economic component applies partial budget analysis at the hectare level, expressed as a return per leu of expenditure, as a break-even yield gain and as the proportion of the crop that would need to be kept within specification, and extends this through scenario modelling to the sector. Sector production and trade data are drawn from national statistical sources and from the Moldova Fruct Association, including its 2018 and 2026 surveys of members' orchards; technical and cost data are drawn from the commercial records and crop budgets of the case-study enterprise.

Structure of the thesis. The work is organised in three chapters. Chapter I establishes the theoretical foundations in four sections, covering the concepts and measurement of competitiveness in horticultural value chains, a structural assessment of the Moldovan apple sector through Porter's diamond, the mechanism and evidence base for pre-harvest ethylene management together with the alternatives actually available to a Moldovan grower, and the determinants of technology adoption in fruit farming. Chapter II diagnoses the Moldovan apple sector, examining its production base and post-harvest capacity, the reorientation of its export markets and the three structural constraints on its competitiveness. Chapter III is devoted to the technology itself: the design and technical results of the commercial application at Viorix-Agro, the hectare-level partial budget derived from them, the sector adoption scenarios these results support, and the conditions

for implementation. Conclusions and recommendations follow, together with the bibliography and annexes.

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