

WALNUT CULTIVATION TECHNOLOGY

Volodymyr Mezhenkyj, Professor
Prof. V. L. Symyrenko Department of Horticulture of the National
University of Life and Environmental Sciences of Ukraine





INTRODUCTION: VOLODYMYR MEZHENSKYI

Doctor of Agricultural Sciences; Senior Researcher;
Member of the International Society for Horticultural Science (ISHS)

co-breeder of the walnut varieties ‘Podilskyi’, ‘Podilskyi Bokoplidnyi’, and ‘Stryzhavskyi Paperovyi’



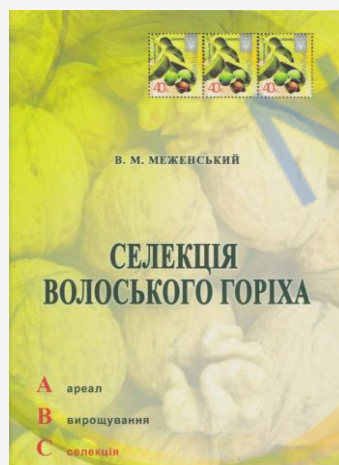
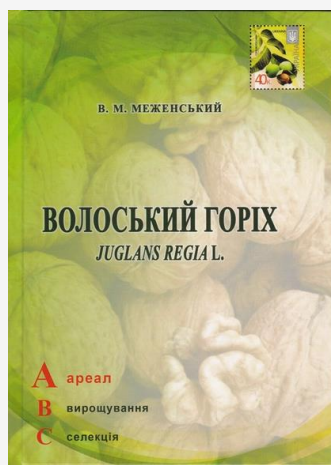
INTRODUCTION: VOLODYMYR MEZHENSKYI



Author of the books “The Walnut
(*Juglans regia* L.)” (2020)
“Walnut Breeding” (2022)
“Walnut Cultivation” (in progress)

**The gene pool collection of the
National University of Life and
Environmental Sciences of
Ukraine comprises 90 varieties
and variety forms:**

- standard walnuts;
- lateral walnuts;
- “bombs”;
- interspecific hybrids



WALNUT VIS WALNUT

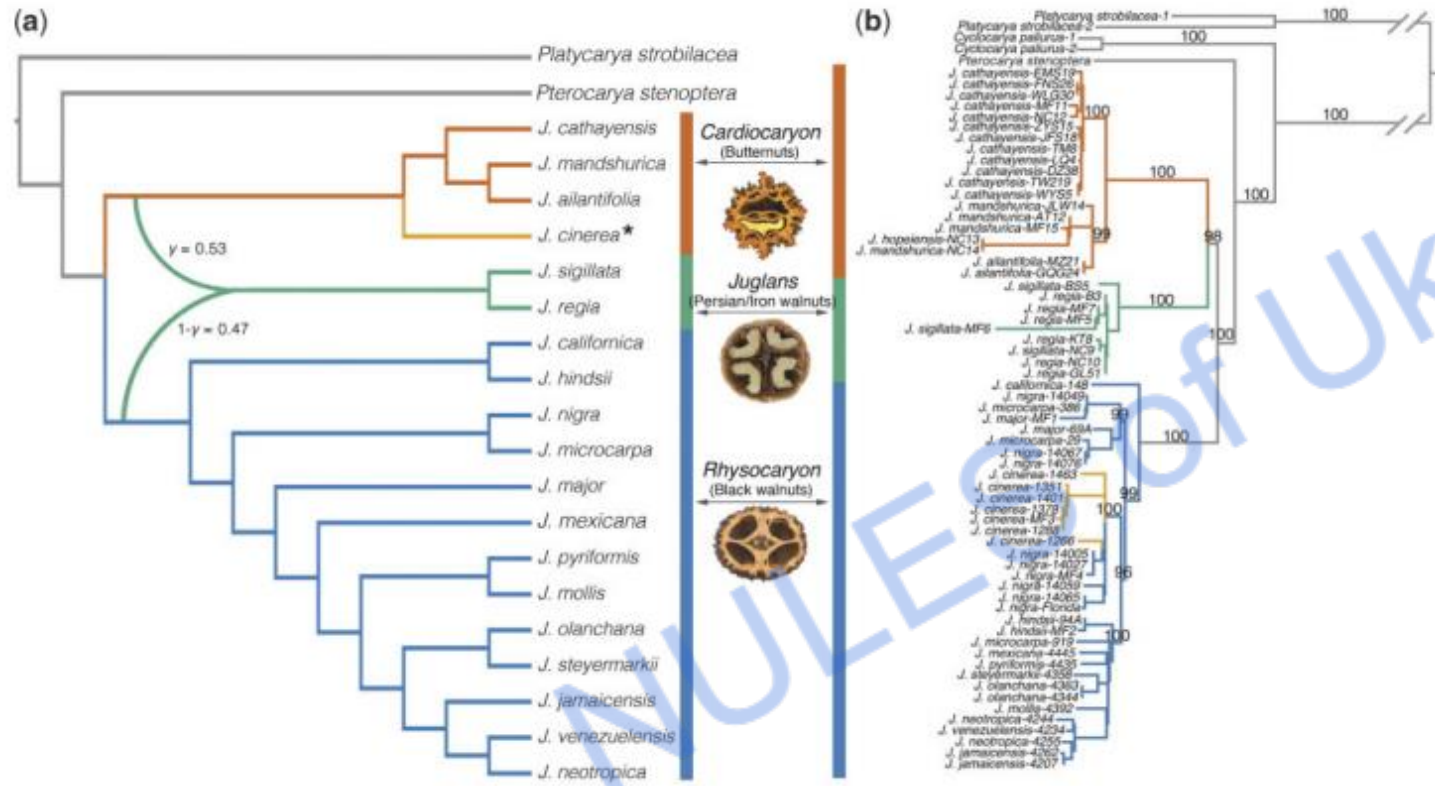
Орѣхъ волосый, *Juglans regia*.
XVI. Меду пресные липъци, орѣхи волоские
сухие и черные въ меду Арх. ЮЗР. I, I, 362
(1593).
XVII. Отъ бочки орѣховъ волоскихъ по
грошей два (мыта) Ак. ЗР. IV, 250 (1606).
XVIII. Купилося... орѣховъ волоскихъ
14 тысячъ Вас. 36. Мат. Лівоб. Укр. 75
(1721).

In the earliest Ukrainian literary sources, *Juglans regia* has been known by the name “Voloskyi orikh” since the late 16th century.

Although the term “Hretskyi horich” is a Ukrainianism in Russian, in Ukrainian, the use of the adjective “Hretskyi” (=“Greek”) when referring to *Juglans regia* is considered incorrect. More than twenty Ukrainian dictionaries from the 19th and 20th centuries that list plant names use the term “Voloskyi horikh,” and only two Russified dictionaries, published during the Soviet era when official policy was to align national terminology with Russian, use the term “Hretskyi horich”. Unfortunately, the Russian name for the species made its way into the State Register of Plant Varieties of Ukraine, where *Juglans regia* varieties are registered under a foreign name.

Replacing the specific Ukrainian name for *Juglans regia*, “Voloskyi horikh” with the Russified term “Hretskyi horich” is unjustified and requires a correction in scientific terminology.

THE ORIGIN OF JUGLANS REGIA L.



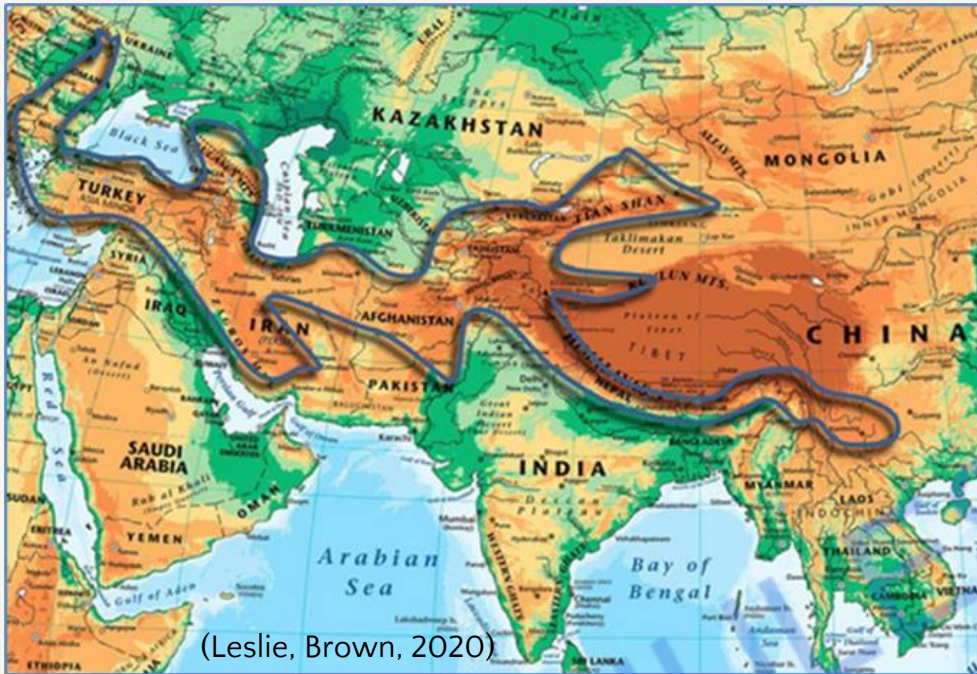
Phylogenomics Reveals an Ancient Hybrid Origin of the Persian Walnut

Bo-Wen Zhang^{†,1} Lin-Lin Xu,^{†,1} Nan Li,^{†,1} Peng-Cheng Yan,² Xin-Hua Jiang,¹ Keith E. Woeste,³ Kui Lin,^{*1} Susanne S. Renner,^{*4} Da-Yong Zhang,^{*1} and Wei-Ning Bai^{*1}

Mol. Biol. Evol. 36(11):2451–2461 doi:10.1093/molbev/msz112 Advance Access publication June 4, 2019

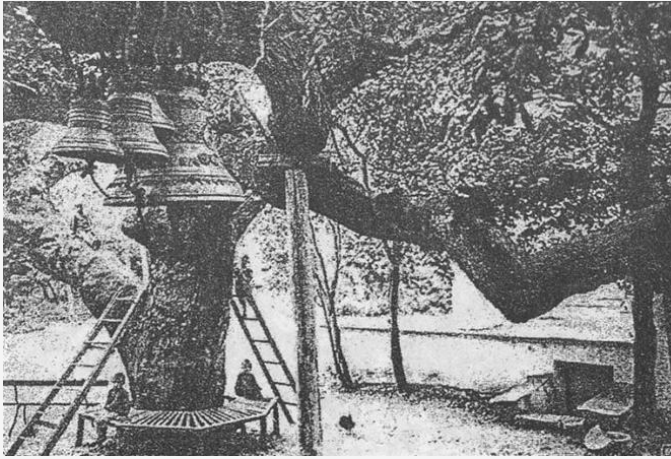
The walnut originated as a result of hybridization between ancestral forms of American black walnuts (section *Rhysocaryon*) and Asian walnuts (section *Cardiocaryon*). This event occurred approximately 3.45 million years ago during the late Pliocene.

THE RETURN OF THE WALNUT TO UKRAINE



As a result of the last ice age, which began 115,000 years ago and peaked 20,000 years ago, the walnut retreated southward. About 3,000 years ago, in what were then Assyria and Media, the walnut was truly domesticated. After Alexander's campaigns, the cultivated walnut, known as the "Persian" or "royal walnut," reached Europe. In terms of heterozygosity, the walnut of Eastern Europe, centered in Ukraine, is second only to the primary gene center in Southwest Asia. The high heterozygosity of Ukrainian varieties makes them more resilient and valuable to global science.

ANCIENT WALNUT TREES



The thousand-year-old tree in Massandra



A 300-year-old walnut tree in the Poltava region

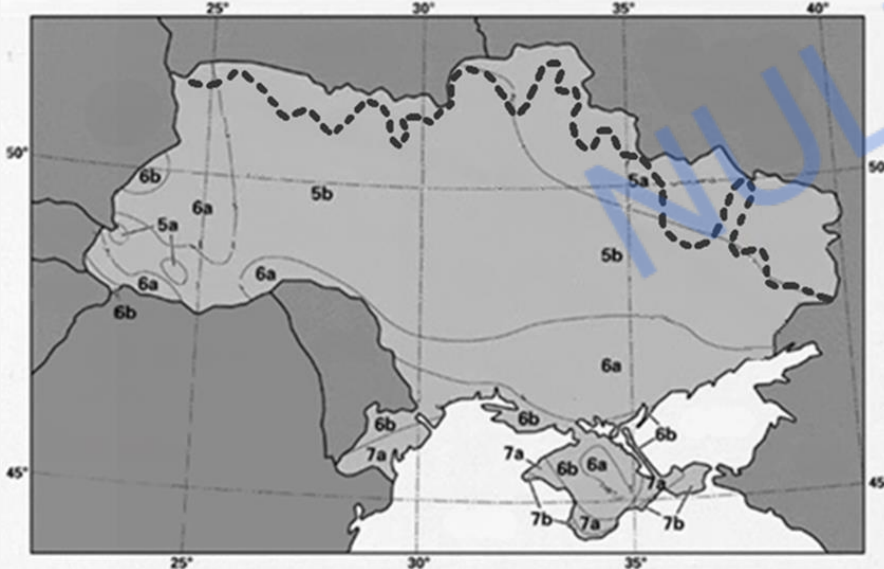


Puzanov's 600-year-old walnut tree Nikulin's 400-year-old walnut tree

LIMITING FACTOR – WINTER FROST



Absolute minimum air temperature (°C)



- USDA Hardiness Zones**
- 5a from -28.8 to -26.2 °C
 - 5b from -26.1 to -23.4 °C
 - 6a from -23.3 to -20.6 °C
 - 6b from -20.5 to -17.8 °C
 - 7a from -17.7 to -15.0 °C
 - 7b from -15.0 to -12.3 °C



High-quality nut orchards damaged by frost (2015–2016).

The dotted line indicates the northern boundary of the walnut's range

DAMAGE CAUSED BY SPRING FROST



As a result of global warming, the frequency of extreme weather events is increasing.

- Use of late-season varieties
- Careful selection of a garden site
- Use of a wide range of frost protection measures

THE ROOT SYSTEM OF THE WALNUT TREE



The root system of a 10-year-old tree



The root system of a 200-year-old tree

The walnut tree is sensitive to water availability, especially when young, when it requires more irrigation. At the same time, young plants should be irrigated in a way that encourages the development of a deep root system.

Plantations established with grafted seedlings are only viable with artificial irrigation.

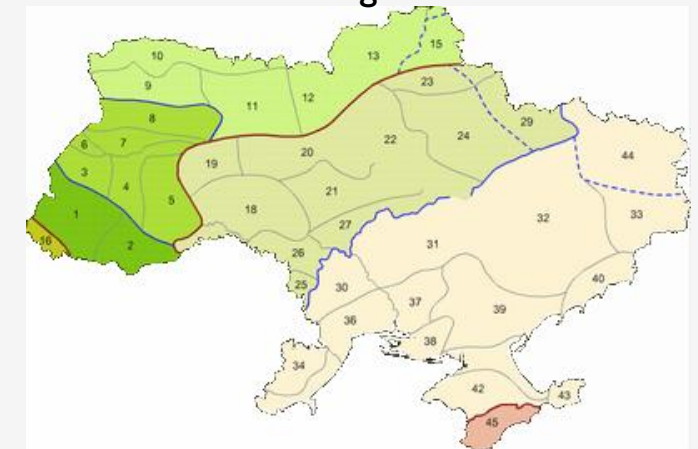
GROWTH REQUIREMENTS

The best soils are fresh, deep, fertile soils—well-aerated calcareous and loamy soils. The walnut tree is similar to light-loving plants. Under shaded conditions, the yield decreases by two to three times. For the growth and development of walnut trees and to achieve maximum yields, the water table must be at a depth of 2.5–3.0 m, but no closer than 2.3 m from the soil surface.

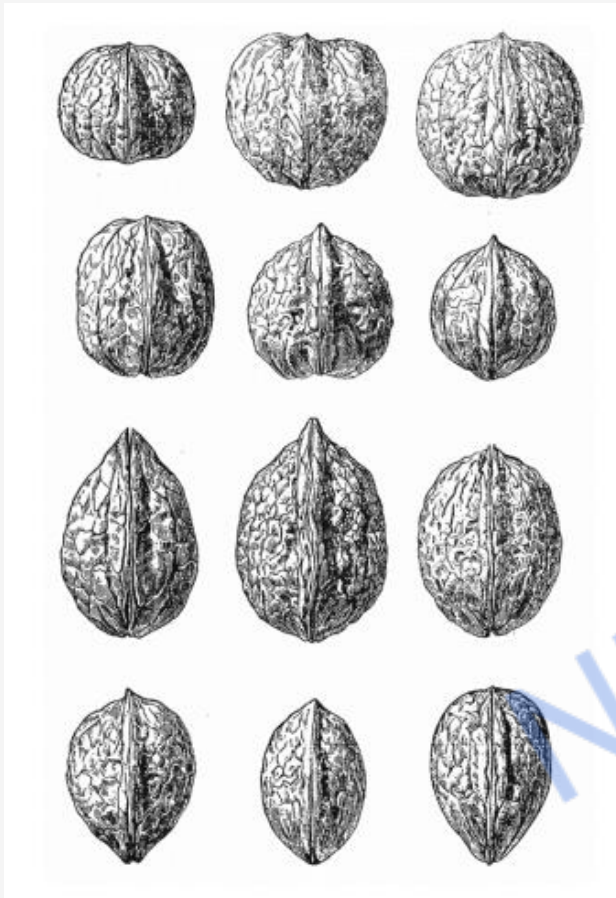
Summer temperatures above 30°C significantly reduce fruit quality. Due to sunburn in June–July, many fruits fail to develop kernels or remain underdeveloped, while the shell thickness increases. The negative impact of high air temperatures is particularly pronounced under conditions of insufficient soil moisture. In such cases, a significant portion of the fruits fall prematurely, while others become smaller and form small kernels.



Geobotanical Zoning of Ukraine



A VARIETY OF NUTS

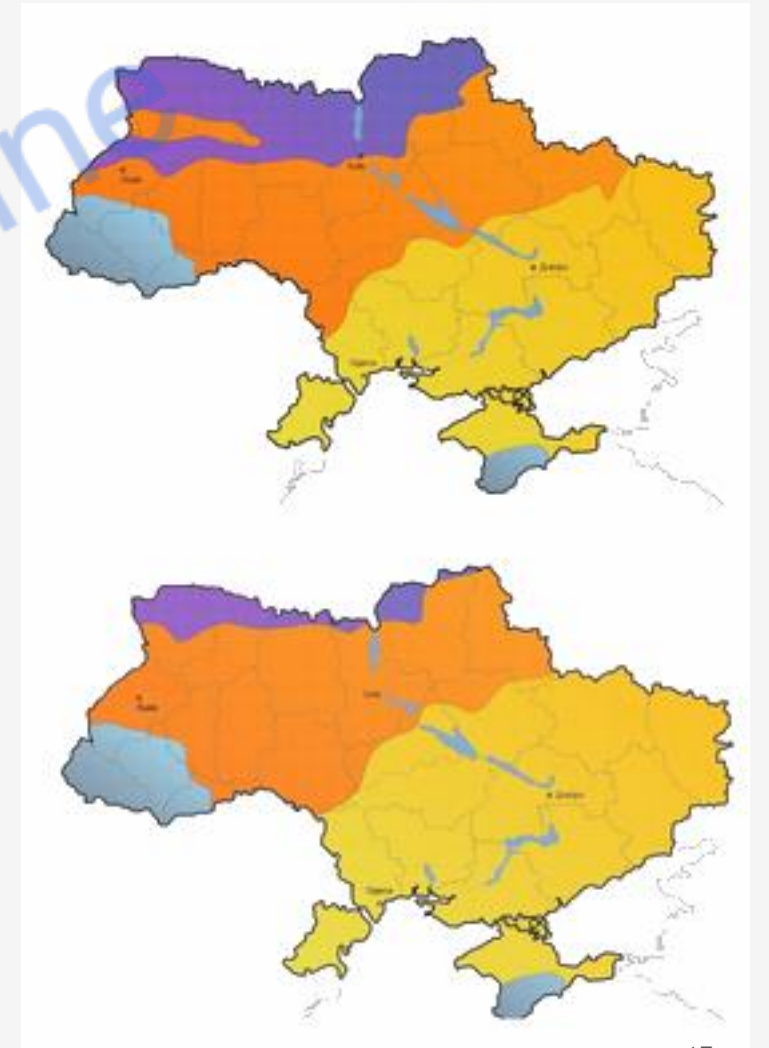
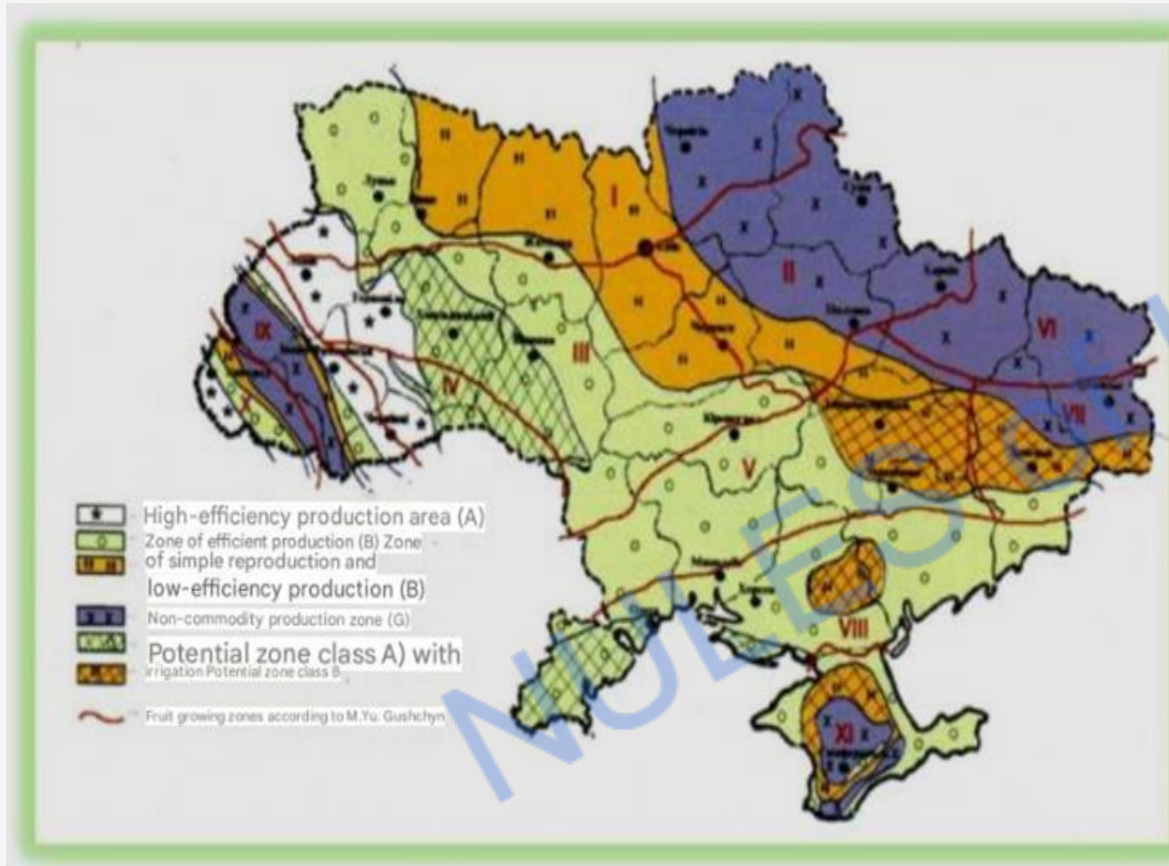


Variety by shape



1. Variety by size
2. 2. Variety by surface texture
3. 3. Variety by shell thickness

AGROECOLOGICAL ZONING OF UKRAINE FOR WALNUTS



PHENOLOGICAL PHASES OF FLOWERING



Phenophases of male flowers



Phenophases of female flowers

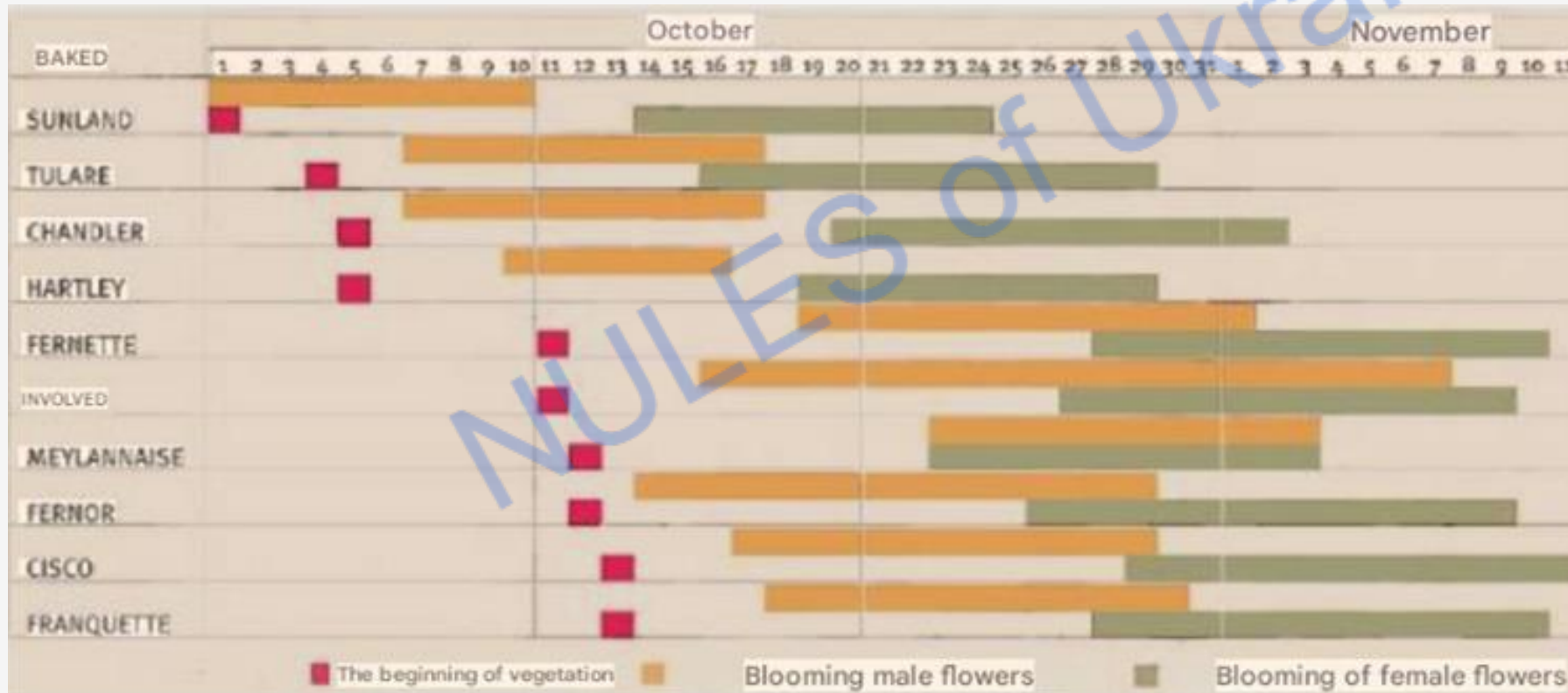
The walnut is a wind-pollinated monoecious plant with unisexual flowers

PHENOLOGY OF FLOWERING IN WALNUT VARIETIES

Technologic Problems to Face when Establishing Walnut in New Cold Areas: the Experience in the Southern Hemisphere

L. Iannamico
 Alto Valle Experimental Station
 National Institute of Agricultural Technology – INTA
 Argentina

Proc. VIIth International Walnut Symposium
 Acta Hort. 1050, ISHS 2014



DICHOGAMY:
 the asynchronous ripening of stamens and pistils

FLOWERING TYPE:

- Protandrous
- protogynous
- homogamous

Flowering of varieties under Patagonian conditions, Argentina

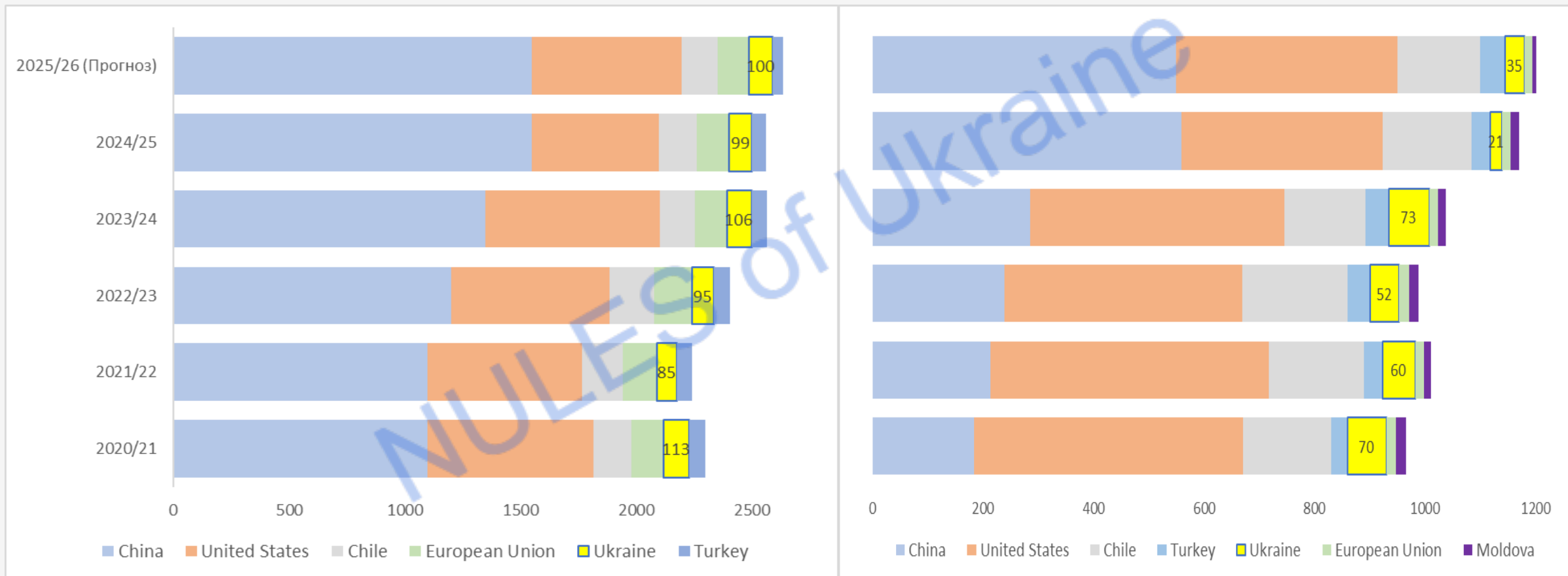
COMPARISON OF THE BIOCHEMICAL COMPOSITION OF NUTS, CONTENT (%)

Nut cultivation	Water	Protein	Oil	Saturated fatty acids	Unsaturated fatty acids	Omega-6 : omega-3	Sugars	Starch	Carbohydrates	Dietary fiber	Minerals
Walnut	3,8	16,2	60,8	6,2	50,1	4:1	3,9	7,2	11,1	6,1	2,0
Hazelnuts	4,8	15,0	61,5	4,4	50,0	90:1	3,6	5,8	9,4	3,4	3,4
Almonds	5,3	18,6	56,7	5,0	44,2	200:1	6,0	7,0	13,0	7,0	3,7
Cashew	5,3	18,5	48,5	8,5	30,1	50:1	7,6	15,0	22,5	2,0	3,2

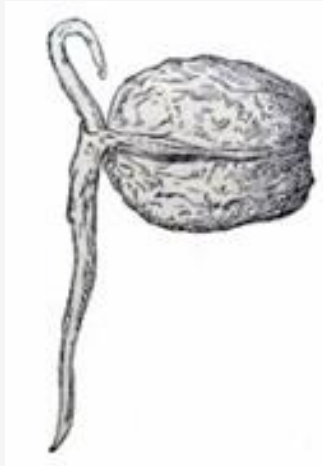
VITAMINS IN NUTS, MG/100 G

Nut cultivation	Carotene, provitamin A	Tocopherol, E	Thiamine, B1	Riboflavin, B2	Bioflavonoids, P	Niacin, B3	Pyridoxine, B6	Ascorbic acid, C	Calories, kcal
Walnut	50	2,6	0,39	0,12	1,2	4,8	0,53	5,8	656
Hazelnut	10	20,4	0,30	0,10	2,0	5,2	0,57	1,4	651
Almonds	20	24,6	0,25	0,65	4,0	6,2	0,13	1,5	609
Cashew	0	5,7	0,50	0,22	2,1	6,9	0,42	0	600

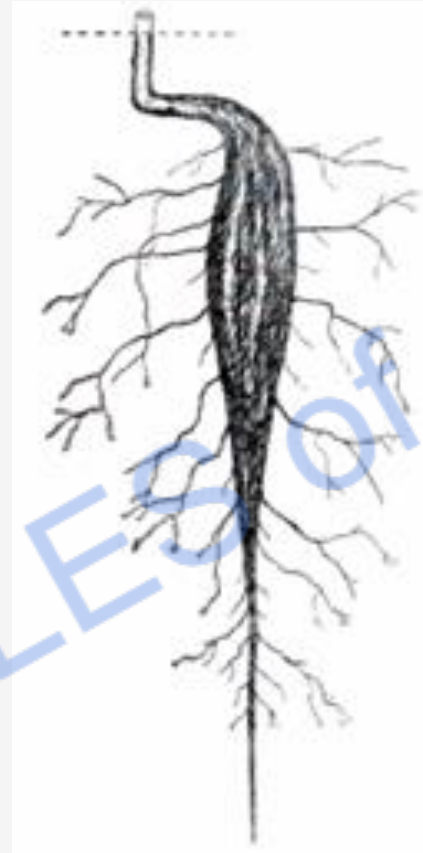
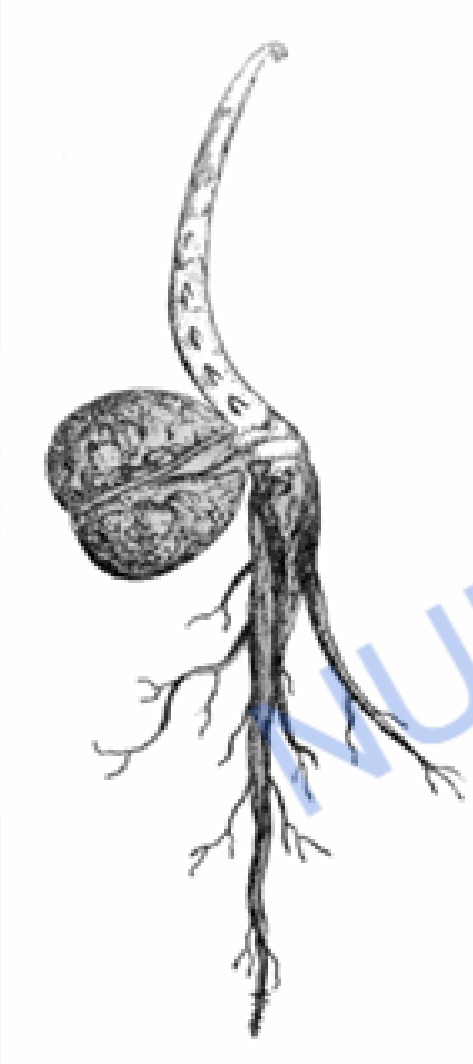
PRODUCTION AND EXPORT OF NUTS, THOUSANDS OF TONS



PROPAGATION BY SEED



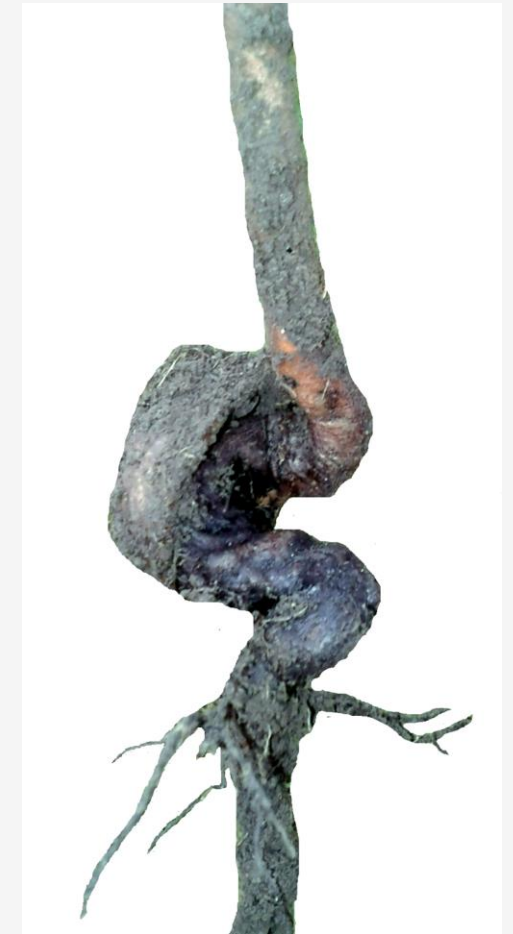
The early stages of germination of nuts



Thickening of the annual root



Annual seedling



Root curvature

Early-bearing walnuts



BARE-ROOT SEEDLINGS



Grafted seedlings in the nursery



Dug-up seedlings

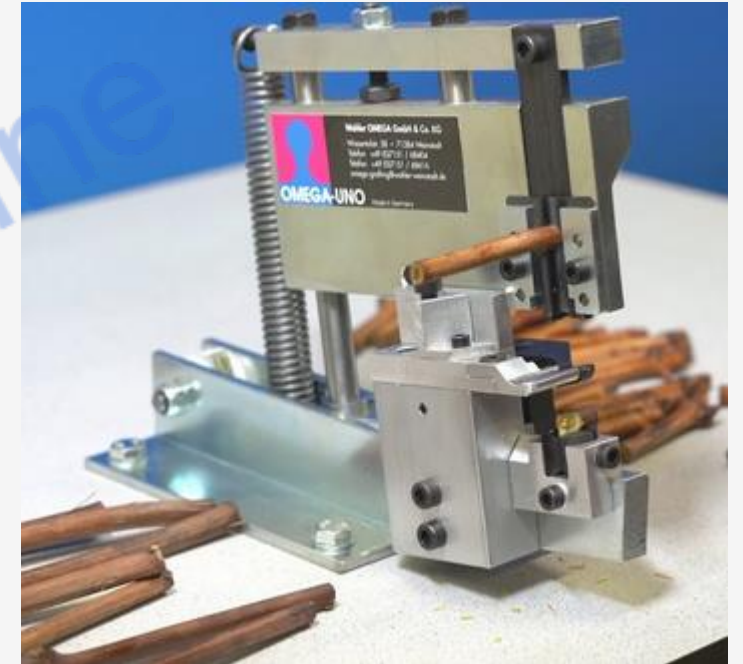
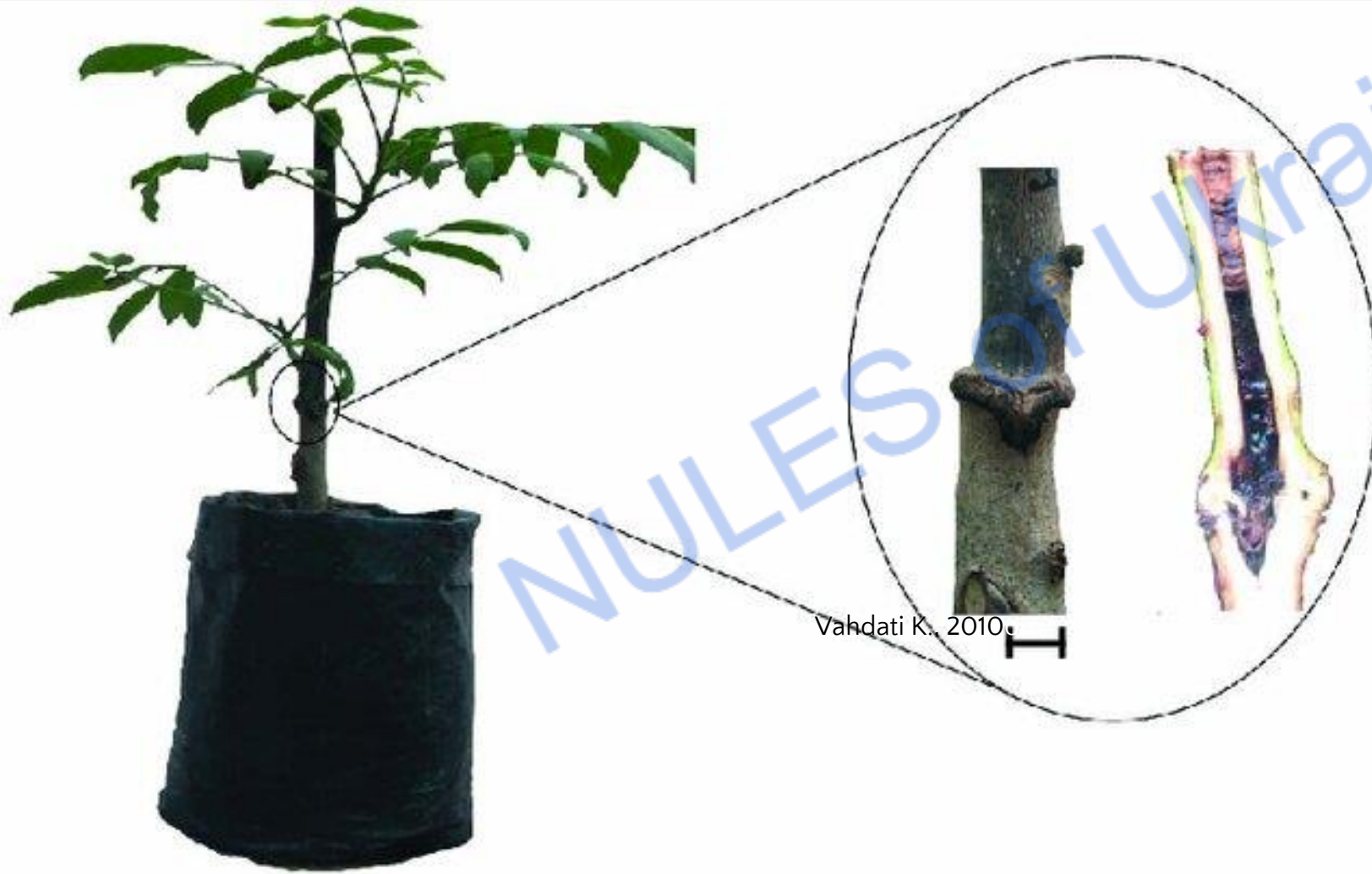
VEGETATIVE PROPAGATION BY WINTER GRAFTING



The process of grafting cultivars onto seedling rootstocks:

- preparing the rootstocks;
- preparing the scions;
- grafting by copulation or using the Ω -cut;
- waxing the grafts;
- stratifying the grafts

SEEDLINGS WITH A CLOSED ROOT SYSTEM



A machine for winter grafting using the Ω -cut method and a seedling produced by this grafting method

MICROCLONAL PROPAGATION



Vahdati et al., 2022

Microclonal propagation is the most promising method for propagating walnut trees, as it allows for the production of countless plants from a minimal number of explants in a short period of time—about a year.

CULTIVARS DEVELOPED BY UKRAINIAN INSTITUTIONS

G.M. Vysotsky Ukrainian Research Institute of Forestry and Agroforestry

'Kolhospnyi' (1991)
'Krasavets' (2018)
'Kurzym' (2018)
'Shchepotievskyi' (1998)

L.P. Symyrenko Pomological Station

'Promin' (2016)

Prydnistrovska Station

'Bukovynska Bomba' (1995)
'Bukovynslyi 1' (1996)
'Bukovynskyi 2' (1995)
'Hetman' (2019)
'Klishkivsky' (1995)
'Krasen' (2019)
'Legin' (2016)
'Prydnistrovskyi' (1997)
'Prykarpatskyi' (1995)
'Rudkivskyi' (2007)
'Toporivskyi' (1995)
'Chernivetskyi 1' (1997)
'Chernivetskyi 2' (2012)
'Yablunivskyi' (2012)
'Yarivskyi' (1995)

Nikitsky Botanical Garden

'Alminskyi' (2014)
'Arkad' (2014)
'Bospor' (2014)
'Burluk' (2014)
'Karlyk 3' (2010)
'Karlyk 5' (2010)
'Konkersnyi' (2014)
'Podarunok Valentyny' (2010)
'Pamiaty Pasenkova' (2014)
'Purpurovyi' (2010)

VARIETIES DEVELOPED BY UKRAINIAN PRIVATE INDIVIDUALS

‘Alex’ (2024)

‘Alona’ (2019)

‘Bit Kharkivsky’ (2023)

‘Boghatyr’ (2024)

‘Boryshkivetskyi 1’ (2018)

‘Webu 6’ (2019)

‘Halchynskyi 6’ (2019)

‘Dnipro’ (2020)

‘Yefrem 1’ (2019)

‘INTR’ (2015)

‘Lysychanskyi’ (2016)

‘Oleksandr Velykyi’ (2019)

‘Pamiat Zatokovoho’ (2016)

‘Pamiat Kocherzhenka’ (2019)

‘Pamial Pasieki’ (2019)

‘Paramonivskyi’ (2024)

‘Podilskyi’ (2020)

‘Podilskyi Bokoplidny’ (2020)

‘Sir Majestic’ (2018)

‘Skarb’ (2024)

‘Slava Ukrainy’ (2016)

‘Soika’ (2019)

‘Stryzhavsky Paperovyi’ (2020)

‘Feniks’ (2020)

FOREIGN BREEDING VARIETIES

Moldova

'Cazacu' (2017)
'Calarașchi' (2009)
'Chișiniovschi' (2009)
'Cogilniceanu' (2017)
'Codrene' (2009)
'Corjeuțchi' (2009)
'Costiujenschi' (2009)
'Lunguiețe' (2009)
'Pescianski' (2018)
'Schinoschi' (2009)
'Taisia' (2019)
'Timofei' (2019)

France

'Meylannaise' (2011)
'Pieral' (Lara®) (2011)
'Ronde de Montignac' (2011)
'Ferjean' (2009)
'Fernette' (2009)
'Fernor' (2009)
'Franquette' (2011)

United States

'Chandler' (2016)

CHOOSING A VARIETY

Choosing a variety for establishing a commercial walnut orchard is a strategic decision that determines the profitability of the business for decades to come. It is essential to take into account a range of biological and climatic factors.

- 1. Climate and soil conditions.** Varieties must be sufficiently winter-hardy for the growing region. In areas prone to late spring frosts, varieties with a late start to the growing season should be selected. Soil analysis prior to planting.
- 2. Fruiting type (lateral, terminal).** Lateral varieties are more productive and, as a rule, have a shorter growth habit, so they are planted using denser spacing patterns.
- 3. Characteristics of nuts:** nut weight, color, kernel yield, and shell thickness.
- 4. Pollination.** Ensuring cross-pollination while taking into account dioecy.
- 5. Planting stock.** Grafted or grown from seed.

ROOTSTOCKS



A walnut orchard grafted onto 'Paradox' rootstock

SEEDLINGS

1. *Juglans regia* seedlings;
2. *Juglans nigra*, *J. hindsii*,
J. hindsii × *J. regia* +
J. microcarpa × *J. regia*
(‘Paradox’ hybrids);
3. *Pterocarya stenoptera* seedlings

CLONES

- ‘Vlach’, ‘VX 211’ (*J. hindsii* × *J. regia*);
‘RX 1’ (*J. microcarpa* × *J. regia*);
‘MRJ 17’ (*J. major* × *J. regia*)

WALNUT ORCHARDS



Rafael B.J., 2019



Rafael B.J., 2019

Tree planting schemes ranging from 6 x 4 to 15 x 12 m



Rafael B.J., 2019



Rafael B.J., 2019

The rows in a young orchard are left to grow wild; vegetable, forage, and grain crops are grown; fruit trees and shrubs are temporarily planted

In addition to the walnut kernels themselves—the primary reason walnuts are grown—walnut orchards also provide green fruits with exceptionally high levels of vitamin C and bioflavonoids, as well as husks, shells, leaves, pollen, and more. Felled trees serve as a source of high-quality timber.

Rafael B.J., 2019

ESTABLISHING PLANTATIONS

Economic justification and business plan: Purpose (own consumption, local market, or export), logistics.

Selecting a suitable site: Climate and weather conditions, soil (physical and chemical properties, hydrology)

Orchard design: Topography, site layout, irrigation system plan

Selecting the best variety: Terminal or lateral fruiting type, pollinator varieties, seedlings with closed or open root systems, seedling quality, nut quality

Application of proper technology: Establishment of orchard shelterbelts, soil preparation, planting time, nutrient zone, fertigation setup, pre-bearing care (nutrient supply, canopy formation, protection against pathogens), care for the bearing orchard, harvesting, post-harvest

ALLEY AND PHYTOMELIORATIVE PLANTINGS



Thanks to its rapid growth, the walnut tree is well-suited for use in roadside and orchard buffer strips. It is planted along highways, railroads, ponds, and other bodies of water, as well as in erosion-control plantings on slopes and in mountainous areas.

It is advisable to establish single-row and alley-type pure-species strips of walnut trees with a spacing of 10 meters between trees so that they can fully perform their protective and beneficial functions. At the same time, they serve as a source of walnuts, which are actively harvested by the local population. Properly designed protective strips, whether pure walnut or mixed, have high protective properties and also serve as a source of fairly high walnut yields. Walnut trees can be planted on low-yielding land unsuitable for agriculture.

AGROFORESTRY



The practice of intercropping nut trees with field crops and grazing cattle in the rows between them is becoming increasingly common.

Rafael B.J., 2019

A double-row planting system is used, with free access to the trees and the space between rows reserved for other crops, which occupy 60% of the total area.

WALNUTS IN FOREST CROPS



Fernández-Moya J. et al., 2019

Studies in Ukraine have shown that establishing sparse stands of walnut trees or introducing them as a mixture with oak or ash is not advisable, as walnut trees require significantly more agricultural and silvicultural care when young.

Forest plantings where walnut trees are interplanted with other trees and shrubs have proven successful. In order to obtain both timber and walnut fruit, thinning should be carried out more frequently than in stands of other tree species, as young walnut trees grow very quickly. After the final thinning in 20-year-old stands, no more than 800–1,000 of the best trees are left. Subsequently, 200–250 are retained.

COMBATING GLOBAL WARMING



Fernández-Moya J. et al., 2019

Effective CO₂ Absorption

- A single tree absorbs 20–50 kg of CO₂ per year. Over its lifetime, a walnut tree accumulates tons of carbon in its wood, roots, and leaves.
- A large leaf surface area ensures intensive gas exchange. After the leaves fall, organic carbon partially enters the soil, improving its fertility and water-holding capacity.

Carbon Sequestration in Wood

- Using walnut wood in furniture and construction sequesters carbon, preventing it from returning to the atmosphere.
- A robust root system promotes deep carbon sequestration in the lower soil layers, which is a more stable storage method than above-ground biomass.

Agricultural Land Improvement

- Ideal for sustainable land use in the context of global warming, as it reduces the temperature of the surface air layer and minimizes moisture evaporation; it stabilizes the soil, preventing its degradation, which is accompanied by greenhouse gas emissions.

DISEASES OF THE WALNUT TREE



Brown spot of the walnut (caused by *Ophiognomonia leptostyla*; *Marssoniella juglandis*). **Prevention:** Collect and burn fallen leaves in the fall. **Chemical control:** Spraying with copper-based products (1% Bordeaux mixture, “Median Extra”) before bud break, then after flowering, and again 10–14 days later.

Black spot of the walnut (caused by *Xanthomonas arboricola* pv. *juglandis*). **Treatment:** Use of bacteriophages and biofungicides based on them, or copper-based fungicides. It is important to treat the trees during flowering, as the bacterium is transmitted via pollen. Fruits showing signs of bacterial spot are not permitted for sale..



White spot disease of the walnut (caused by *Pseudomicrostroma juglandis*). **Fungicides:** Systemic fungicides (such as those based on tebuconazole or azoxystrobin) are effective. **Nutrient management:** A balanced potassium supply strengthens the leaves' resistance to spot diseases.

PEST OF THE WALNUT TREE



Apple fruit moth – *Cydia pomonella*. **Pheromone traps:** Used to monitor the start of the moths' flight period in order to determine the exact timing of treatment. **Insecticides:** Coragen, Ampligo, or Match during the mass emergence of caterpillars. **Orchard hygiene:** Collection and disposal of windfall fruit.

The *pyrina* moth (*Zeuzera pyrina*). **Mechanical and chemical:** Injecting insecticide directly into the entrance hole using a syringe. **Pruning:** Removing and burning damaged branches that have begun to dry out. **Systemic pesticides:** Watering at the base of the tree or spraying with systemic insecticides that penetrate the tree sap.



Walnut fruit fly – *Rhagoletis completa*. **Yellow sticky traps:** Capture of adult flies. **Soil tillage:** The fly overwinters in the soil beneath the tree; deep tilling in the fall destroys the pupae. **Chemical control:** Mid-summer application of contact-intestinal insecticides (e.g., Confidor or Actara).

Pests of Walnuts



Walnut gall mite – *Aceria erinea*



Walnut wart mite – *Aceria tristriatus*

Acaricides: Acaricides such as Vertimec, Envidor, or sulfur-based products (colloidal sulfur) are required. Treatment timing: The most critical time is the “bud break” stage, when mites emerge from their overwintering sites onto young leaves. Natural enemies: As part of ecological programs, the development of predatory mites (phytoseiids) is encouraged, as they naturally regulate pest populations.



Fall webworm – *Hyphantria cunea*

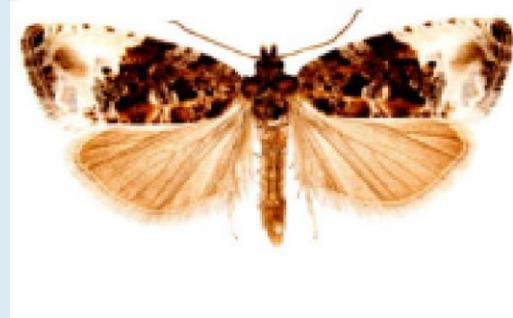
Mechanical method: The most effective way to remove and burn web nests along with the caterpillars before they spread throughout the tree. Biological method: Use of products such as Bitoxibacillin, which are safe for humans and bees. **Chemical method:** In cases of mass infestation, long-acting insecticides are used—Koragen, Belt. (As the climate warms, the gypsy moth may produce not 2, but 3 generations)

PEST OF THE WALNUT TREE



Walnut leaf roller – *Caloptilia roscipenella*. Biological control: Use of products based on the bacterium *Bacillus thuringiensis* (e.g., Lepidocide). This is safe for the garden ecosystem. Mechanical control: Remove and destroy curled leaves on young trees.

Fruit leaf roller – *Hedya nubiferana*. Spray with mineral oil-based products in early spring before bud break to destroy overwintering eggs. During bud break, systemic and contact-action products such as Engio and Coragen are effective..



Walnut aphids – *Chromaphis juglandicola*. Biological control: Preserving natural enemies—ladybugs and lacewings. Spraying: In case of a mass outbreak, use mild insecticides (Bi-58 New or imidacloprid-based products).

PEST OF THE WALNUT TREE



Large birds and some mammals can damage walnut crops. Controlling squirrels, crows, and jays in a walnut orchard is one of the most challenging tasks, as these animals are highly intelligent and quickly become accustomed to standard deterrent methods.

Protective netting, taste repellents, sound deterrents, and live deterrents—dogs.

POSSIBLE MEASURES TO BE TAKEN IN THE EVENT OF EXTREME WEATHER CONDITIONS

Technologic Problems to Face when Establishing Walnut in New Cold Areas: the Experience in the Southern Hemisphere

L. Iannamico

THE PROBLEM	DECISION	
Frosts	Selection of varieties	Not available
	Trees with a late start to the growing season	Low to medium
	Passive protection (natural barriers)	Low to medium
	Active protection (spraying, etc.)	Very high
	Deep-soak irrigation	Not available
	Power Management (K, P, B, Z)	Not available
	The Use of Saline Solutions	Low
Winds	Protective forest belts	Low to medium
	Protective plastic mesh	High
	Use of supports	Average

“None” means that the strategy is implemented solely by adjusting the production schedule or making decisions during the planning phase, rather than by purchasing additional protective equipment.

BEST PRACTICES IN THE CONTEXT OF CLIMATE CHANGE

Off-grid power supply	Solar power plants, wind farms, biogas plants
Biological fertilizers and plant protection products	Humates; use of bacteriophages Xaj and Xh and biofungicides (Fitosporin, Fitocid, Gaupsin, Plantoriz) against bacterial blight
Cover crops and crop rotation, soil conservation	Legumes, vegetables, honey plants, and cereals in the garden's row spaces; rotation of fallow, sod-humus, and green manure systems
Early warning system	In the event of spring frosts
Eco-friendly packaging	For shelled nuts
Composting and mulching	Using pruning waste for composting and mulching
Field buffer strips	The walnut tree itself in orchard and field shelterbelts. The role of trees in altering microclimatic conditions on agricultural land can be significant in mitigating heat stress.
Precision and drip irrigation	An essential component of a modern intensive garden
Varieties adapted to the region	It couldn't be any other way
Protective nets and films	They can protect against hail, birds, and animals
Precision farming and fertilizer application	Automated fertigation tailored to the plant's growth stages and nutritional needs

HARVESTING



The nuts are ready for harvest when the green husks have split open on 70–80% of the nuts on the tree. Consequences of premature harvesting: difficulty in shelling, lower yield, and reduced flavor.

On small plots, harvesting is done by hand by shaking the trees. Special hand-held harvesters are used.

In commercial orchards, tractor-mounted shakers (vibrators) are used, which grip the trunk and shake off all the fruit in a matter of seconds. Then harvesting machines—self-propelled or trailer-mounted vacuum cleaners and combines—pick up the nuts from the ground, simultaneously cleaning them of leaves and twigs.

To obtain a light-colored kernel of the highest grade, follow these steps:

Soil preparation: Before harvesting, mow the grass between the rows and level the ground.

Shaking should be done in dry weather.

The nuts should not remain on the ground for more than 24 hours, as moisture from the soil promotes mold growth.

Transportation: The harvested nuts are immediately transported to the post-harvest processing facility.

POST-HARVEST PROCESSING

Post-harvest processing is a critical stage that determines the product's quality grade according to UNECE standards. Because walnuts have a high fat content, improper processing leads to rancidity of the kernel and the development of mold.

- 1. Remove the green husk as soon as possible after harvesting the nuts.**
- 2. Cleaning and Disinfection.**
- 3. Drying.** Freshly harvested walnuts have a moisture content of about 40%, and for long-term storage, this must be reduced to 8–10% (for the kernel, to 5%). The temperature must not exceed 38–40°C. Container-type dryers with forced ventilation are used..
- 4. Calibration using calibration machines to produce uniform batches of goods.**
- 5. Grinding and sorting the kernel by size and color.**
- 6. Packaging and storage.** Whole nuts are packaged in 25-kg mesh bags, while kernels are packaged in vacuum-sealed bags or cardboard boxes. Store at a temperature of +5...10°C and low humidity to protect against food moths and rancidity.

UNECE STANDARD DDP-01 (INSHELL WALNUTS)



Moisture content: fresh nuts—at least 20.0%; dry nuts—no more than 12.0% for whole nuts and 8.0% for kernels. For fresh nuts, the inner membrane must show signs of darkening.

Classes: superior (“Extra” class), first (Class I), second (Class II). The minimum diameter (size) for superior and first grades is 26 mm, for second grade—24 mm. Sizing is mandatory for superior and first grades.

Minimum product requirements: free of foreign odors or tastes and abnormal moisture content.

Shell: whole, clean, without significant blemishes; kernel: not rancid, sufficiently developed (no more than 25% of the surface of the kernel is shriveled), free from mold and live pests.

Packaging labeling requirements:

Identification: Name and address of the packer and/or dispatcher.

Product description: “Walnuts” or “Dry walnuts”; “Fresh walnuts”; name of variety or commercial type.

Origin: Country of origin of the product.

Characteristics: Class, size, and crop year.

NUCLEAR FUEL QUALITY IN ACCORDANCE WITH U.S. REQUIREMENTS

UNITED STATES DEPARTMENT OF AGRICULTURE

Consumer and Marketing Service

WALNUT COLOR CHART

(For classifying walnut kernels in connection with the United States Standards for Grades of Shelled Walnuts and the United States Standards for Grades of Walnuts in the Shell)



DARKEST COLOR PERMITTED IN "EXTRA LIGHT" CLASSIFICATION



DARKEST COLOR PERMITTED IN "LIGHT" CLASSIFICATION



DARKEST COLOR PERMITTED IN "LIGHT AMBER" CLASSIFICATION



DARKEST COLOR PERMITTED IN "AMBER" CLASSIFICATION

A



B



C



D



A – extra light

B – light

C – light amber

D – amber



UNECE STANDARD DDP-02 (NUT GRADES)



Minimum requirements: The kernels must be of good quality, clean, well-developed, free from defects, live and dead pests, damage, mold, off-odors and/or off-flavors, non-rancid, capable of withstanding transportation, and with a moisture content not exceeding 5.0%.

Premium Grade (Extra Class)

The kernels must be uniformly light in color, with virtually no dark straw-colored and/or lemon-yellow coloring; dark brown coloring is not permitted.

First Grade (Class 1)

Second Grade (Class 2)

UNECE STANDARD DDP-02 (Provisions concerning sizing)

“halves”: kernels divided into two roughly equal and intact parts [“halves” must account for at least 85%; up to 15% may consist of “chipped kernels” mixed with “quarters” and “large pieces,” each accounting for 5%];

“chipped kernels”: refers to pieces that make up at least three-quarters of a “half” of the kernel. [“Chipped kernels” must account for at least 85%; up to 15% may consist of “quarters,” including 5% each of “large pieces” and “broken pieces”].

“quarters”: the kernels are split lengthwise into four roughly equal parts [at least 85% must be ‘quarters’; up to 15% may consist of “large pieces” and 5% of “broken pieces”];

“large pieces”: pieces of the kernel that are smaller than “chipped kernels” but larger than “broken pieces” [“large pieces” must account for at least 85%, with up to 15% allowed to be “small pieces”];

“broken pieces”: parts of the kernel that pass through a sieve with 8-millimeter round mesh but not through a sieve with 3-millimeter mesh [at least 90% must be “broken pieces”; up to 10% may be “large pieces”]

ВІДЕО



Сучасні горіхові сади (на прикладі Австралії)

<https://www.youtube.com/watch?v=rnh5PUffvW0>



Найбільший промисловий горіховий сад в Україні (Могильов-Подільський, Вінницька обл., Ukrainian Walnut)

<https://www.youtube.com/watch?v=qYfBuFuJ95E&t=27s>