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Exploration of intercropping compound planting between fresh edible corn and fresh edamame

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ABSTRACT Fresh edible corn (*Zea mays* L.) and fresh edamame (*Glycine max* L. Merr.) are highly nutritious crops with increasing consumer demand and expanding cultivation across both northern and southern regions of China. Recognizing their agronomic and economic potential, the No. 1 Document of the Central Committee of the Communist Party of China (2020) emphasized the need to promote high-yielding edamame varieties and to advance intercropping systems involving corn and edamame. However, current production practices predominantly rely on monoculture, resulting in low land-use efficiency, suboptimal resource allocation, and heightened susceptibility to pest and disease outbreaks—factors that collectively constrain productivity gains. This paper systematically reviews key technical measures for the strip intercropping of fresh edible corn and edamame, addressing aspects such as field selection, seed treatment, sowing strategies, integrated pest, disease, and rodent control, as well as fertilizer and irrigation management, and harvesting protocols. This study explores a strip intercropping model integrating fresh edible corn and edamame, aiming to improve yield, land-use efficiency, and agroecosystem stability. The intercropping model aims to optimize planting structure, enhance land-use efficiency, improve resource utilization, and reduce biotic stress. Furthermore, it facilitates nutrient complementarity between crops, supports soil health, sustains the agro-ecological balance, and contributes to higher economic returns for farmers.

Keywords*: edible: corn; edamame; intercropping; complex planting*

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INTRODUCTION Fresh edible corn is a valuable crop rich in sugars, vitamins, and dietary fiber, offering superior palatability and nutritional value compared to conventional corn due to its higher protein and lysine content. It is particularly suitable for direct consumption through steaming or boiling. Similarly, fresh edamame (immature soybean) is a protein-rich legume and a significant source of plant-based protein. In recent years, increasing consumer awareness of health and nutrition has led to a sharp rise in market demand for both crops (Liang et al., 2024). With the growing preference for high-quality and diverse agricultural products, enhancing production efficiency, optimizing cultivation systems, and improving crop resilience to biotic and abiotic stresses have become critical challenges in modern agriculture. Strip interplanting—a space-efficient, three-dimensional cultivation strategy—offers several advantages, including improved microclimatic conditions, enhanced land-use efficiency, and better pest and disease regulation (Liang et al., 2024, Li et al., 2024).

In the intercropping system of fresh edible corn and edamame, optimizing strip width, planting density, and synchronizing sowing and harvesting schedules are essential to achieving high yield and superior quality. Due to differences in their growth durations, susceptibility to pests and diseases, and resource utilization patterns, it is crucial to implement precise, crop-specific management practices. This study provides a comprehensive analysis of strip interplanting models, key agronomic techniques, integrated pest and disease control approaches, optimal harvest timing, and mid-season management strategies, offering theoretical foundations and practical insights for the sustainable and efficient cultivation of fresh edible corn and edamame (Jiang et al., 2022, Wen et al., 2024)

SOIL REQUIREMENTS AND SEGREGATED PLANTING

Soil requirements

Most fresh edible corn varieties exhibit lower seed fullness, smaller grain size, and reduced germination vigor compared to conventional corn, often resulting in lower seedling emergence rates. Consequently, these varieties require more precise sowing techniques and careful seedling management to ensure successful establishment. Fresh edible corn performs best in loamy soils characterized by a loose structure, good drainage, and a neutral to slightly acidic pH (Song et al., 2023, Dong Qian et al., 2014).

In contrast, fresh edamame (immature soybean) demonstrates greater adaptability across a range of soil types. However, optimal yield and quality are achieved in soils with high organic matter content and strong water retention capacity. Notably, fresh edamame engages in symbiotic nitrogen fixation through rhizobial associations, contributing to the soil's nitrogen pool. This biological process can partially offset the nitrogen requirements of the intercropped fresh edible corn, thereby reducing dependency on synthetic nitrogen fertilizers. Such nutrient complementarity between the two crops enhances resource efficiency and promotes environmentally sustainable cultivation practices (Yong et al., 2025, Fan et al., 2019).

Segregated planting

The key quality traits of fresh edible corn—such as sweetness and glutinous texture—are predominantly governed by recessive genes. Therefore, strict varietal management during cultivation is essential, particularly in continuous cropping systems. Effective isolation from other corn varieties is critical to prevent genetic contamination through pollen drift, which can lead to the deterioration of kernel quality (Nasar et al., 2024, Chen et al., 2017).

Cross-pollination with conventional corn or other fresh edible corn varieties can easily result in a phenomenon known as "pollen contamination," which compromises the expression of desired traits. This often leads to the loss or weakening of kernel sweetness and glutinous characteristics, thereby reducing both the palatability and visual appeal of the cobs. Such degradation significantly lowers the commercial value of the crop. To mitigate these risks, robust isolation strategies must be adopted in production systems. Commonly used methods include spatial isolation and temporal isolation. Spatial isolation involves maintaining a minimum distance of 300 meters between fresh edible corn fields and other corn varieties. Additional barriers—such as buffer zones of non-corn crops, natural vegetation, or constructed features like forests and villages—can further reduce pollen flow (Zhang et al., 2015, Ping et al., 2018).

Temporal isolation relies on staggered planting schedules to ensure that the flowering periods of different corn varieties do not overlap, thus avoiding simultaneous pollination. For varieties with similar maturation periods, a sowing interval of approximately 20 days is recommended. When planting early- and late-maturing varieties, the early-maturing ones should be sown first, followed by the late-maturing ones, ensuring their anthesis periods are temporally separated. These isolation techniques are crucial for maintaining genetic purity, preserving desirable quality traits, and enhancing the market value of fresh edible corn (Zhang et al., 2021, Liu et al., 2023).

SELECTION OF VARIETIES

The selection of fresh edible corn varieties should prioritize those with superior quality, strong adaptability, and suitability to the local agroecological conditions (Figure 1). Ideal cultivars should possess desirable agronomic traits, including a compact plant architecture, strong lodging resistance, tolerance to high planting density, stable and high yield potential, moderate to short plant height, and robust disease resistance. In terms of consumption quality, preferred varieties should exhibit characteristics such as thin pericarp, high sugar content, tender texture, and an extended harvesting window. Commonly recommended varieties—such as Jingke Glutinous 837, Ruijia Sweet No. 4, Dayu Glutinous 4, and the Sunflower series—have demonstrated strong agronomic performance and favorable market acceptance across multiple regions (Lin et al., 2022).

Similarly, fresh edamame selection should focus on early-maturing varieties with shorter growth cycles, which are well-suited for intercropping systems. Optimal cultivars should exhibit desirable traits such as vibrant green seeds, tender texture, high protein content, excellent commercial quality, high yield potential, shade tolerance, and resistance to lodging. Varieties such as Yunnan Edamame No. 4, Yunnan Edamame No. 14, Kaikeyuan No. 5, and Kaikeyuan No. 12 have proven to be well-adapted to the local environmental conditions and have achieved notable market acceptance. These characteristics make them suitable candidates for sustainable and efficient compound planting systems (Yin et al., 2024, Yin et al., 2023, Yin et al., Shi et al., 2024).

PLANTING PATTERNS

The core principle of strip interplanting lies in the rational configuration of row arrangements between fresh edible corn and fresh edamame, aiming to optimize spatial distribution, enhance light interception and utilization efficiency, and promote the coordinated growth of both crops.

Strip Intercropping Models

This intercropping system typically involves the cultivation of edamame during spring or summer, with fresh edible corn either sown simultaneously or slightly earlier. This results in an extended period of crop coexistence, facilitating interactions that influence growth dynamics and yield performance. Two representative planting models are outlined below:

Model 1: The total composite strip width is 1.8 meters, incorporating two rows of corn and two rows of edamame.

Corn strip width: 40 cm

Edamame strip width: 30 cm (accommodating two rows with a 30 cm row spacing)

Inter-strip spacing (between corn and edamame): 55 cm

Model 2: The composite strip width is 2.0 meters, consisting of two rows of corn and three rows of edamame.

Corn strip width: 40 cm

Edamame strip width: 60 cm (three rows planted at 30 cm row spacing)

Inter-strip spacing (between corn and edamame): 50 cm

These models are designed to balance spatial competition and resource complementarity, enabling efficient land use, improved microclimatic conditions, and synergistic crop development. The selection of strip configuration should be tailored to local environmental conditions, varietal traits, and production goals.

Strip relay intercropping

This intercropping pattern primarily involves autumn-sown edamame, with planting typically occurring approximately 60 days prior to the harvest of fresh edible corn, resulting in a relatively shorter period of crop coexistence. In this system, corn is generally harvested first, followed by edamame. The following are representative configurations:

Model 1: The total composite strip width is 1.8 meters, incorporating two rows of corn and three rows of edamame.

Corn strip width: 40 cm

Edamame strip width: 60 cm (three rows at 30 cm spacing)

Spacing between corn and edamame strips: 40 cm

Model 2: The composite strip width is 2.0 meters, including two rows of corn and four rows of edamame.

Corn strip width: 40 cm

Edamame strip width: 90 cm (four rows at 30 cm spacing)

Spacing between corn and edamame strips: 35 cm

Plant spacing and density recommendations:

Corn:

Plant spacing: 20 cm (single plant per hole) or 40 cm (double plants per hole)

Planting density: ~4,000 plants per mu

Edamame:

Hole spacing: 15 cm (double plants per hole)

Planting density: ~10,000 plants per mu

For the 2.0-meter-wide composite strip model (2 rows of corn + 3 rows of edamame):

Corn spacing can be adjusted to 18 cm (single plant per hole) or 36 cm (double plants per hole) to maintain a planting density of approximately 4,000 plants per mu.

Edamame spacing should be 18–20 cm (double plants per hole), achieving a planting density of approximately 11,000 plants per mu.

To maximize productivity and economic returns, each region should select appropriate strip intercropping models based on local agroecological conditions, market demand, and price forecasts for fresh edible corn and edamame. In areas with mechanized sowing and harvesting, where standard crop row spacing may limit machine efficiency, the composite strip width and inter-row spacing can be flexibly adjusted to facilitate field operations and enhance management and harvesting efficiency (Zhao et al., 2025, Feng et al., 2022).

SEED PREPARATION AND SOWING

Seed preparation

Seeds selected for both fresh edible corn and edamame cultivation must meet high-quality sowing standards, with a minimum germination rate of 85%, purity not less than 95%, and physical cleanliness not less than 97%. To promote robust seedling establishment and reduce early-stage losses, the use of pre-treated or coated seeds is strongly recommended. Seed coating plays a crucial role in protecting seedlings from soil-borne pathogens and underground pests, thereby supporting healthy and uniform crop emergence (Feng et al., 2022, Yong et al., 2025).

For edamame, it is essential to apply chemical seed treatments prior to sowing. A recommended formulation includes 3–4 mL per kilogram of seed of a 6.25 g/L fludioxonil·metalaxyl suspension concentrate, which exhibits strong antifungal properties and supports improved germination and seedling vigor. To enhance control of underground insect pests, an additional 2–3 mL of 48% thiamethoxam suspension concentrate per kilogram of seed can be incorporated into the seed treatment protocol. This integrated approach not only strengthens pest control efficacy but also contributes to greater uniformity in seedling emergence and overall establishment success (Ping et al., 2018, Wen et al., 2024).

Timely sowing

Both fresh edible corn and fresh edamame are thermophilic crops, with a reproductive cycle typically spanning 80 to 90 days from sowing to optimal harvest for fresh consumption. Seed germination occurs reliably when temperatures remain above 10 °C, while the optimal temperature range for vegetative and reproductive growth lies between 20 °C and 30 °C. Given the substantial overlap in their temperature requirements and growth cycles, these two crops are well-suited for synchronous cultivation under similar climatic conditions. This compatibility allows for flexible sowing strategies, including simultaneous or staggered planting, enabling producers to adjust the cropping schedule in alignment with market demands and to optimize the timing of fresh produce availability. Such flexibility supports more efficient planting rhythm management and enhances the market responsiveness of production systems. Additionally, sowing depth should be tailored to local soil texture and precipitation patterns. A depth of 3–4 cm is generally optimal to ensure adequate moisture absorption by the seeds and to promote uniform and timely seedling emergence (Dong Qian et al., 2014, Shi et al., 2024).

EFFICIENT MANAGEMENT PRACTICES

Seedling inspection, replanting, and thinning management

Approximately 10 days after emergence, it is essential to conduct a timely evaluation of seedling establishment. Any observed gaps or missing plants should be promptly addressed through replanting or transplanting to ensure uniform field coverage. In cases of substantial seedling loss, the use of pre-germinated seeds is recommended to facilitate rapid emergence and maintain stand uniformity. Around 20 days after emergence, thinning and final singling should be performed. Early thinning is advisable to minimize root disturbance to neighboring healthy seedlings. Removing weaker or underdeveloped plants at this stage helps maintain an optimal plant population structure, reduces intra-specific competition, and promotes vigorous and uniform crop development. Proper execution of these early-stage management practices is critical to achieving high yield potential and maintaining crop quality (Lin et al., 2022, Zhang et al., 2021).

Fertilization and irrigation management

Rational fertilization

Fresh edible corn and fresh edamame are characterized by short growth cycles, rapid early development, and brief maturation periods, necessitating precise and timely nutrient management. Due to their distinct physiological requirements, fertilization strategies must ensure a balanced and crop-specific supply of essential nutrients. Fresh edible corn exhibits a high nutrient demand, particularly with strong dependence on nitrogen fertilization, whereas fresh edamame, though capable of biological nitrogen fixation, requires relatively greater inputs of phosphorus, potassium, and other micronutrients (Dong Qian et al., 2014, Ping et al., 2018).

In strip intercropping systems, fertilizers should be applied in accordance with the differential nutrient demands of the two crops to achieve a coordinated and efficient supply of nitrogen (N), phosphorus (P), and potassium (K). The general recommendation is to apply well-decomposed farmyard manure or commercial organic fertilizers as the base, supplemented by timely topdressing of mineral fertilizers to meet dynamic crop needs. High-quality organic fertilizers contribute not only to early crop vigor but also enhance tolerance to abiotic and biotic stresses, while improving final grain and pod quality (Liang et al., 2024, Shi et al., 2024).

Basal Fertilization (Uniform Application for Both Crops)

During land preparation, apply:

1,500–2,000 kg per mu of well-rotted farmyard manure

15–20 kg per mu of compound fertilizer (N-P-K 15:15:15)

This ensures a robust baseline nutrient supply for both crops.

Fertilizer Management Strategies

For Fresh Edible Corn:

First application: From seedling stabilization to the 6–7 leaf stage, apply 8 kg of urea per mu

Second application: From tasseling to pre-pollination, apply 18 kg of urea and 15 kg of potassium sulfate-based compound fertilizer per mu

For Fresh Edamame:

During the seedling stage, apply 6–10 kg of urea per mu to promote vegetative growth and branching

At early flowering, apply 0.3 kg of potassium dihydrogen phosphate per mu as a foliar spray, diluted in water, and apply twice to stimulate flowering, pod development, and seed filling

These targeted fertilization practices are essential for synchronizing the nutrient supply with the critical growth stages of each crop, thereby optimizing yield performance and quality in the intercropping system.

Efficient irrigation

Both fresh edible corn and fresh edamame thrive in warm and humid environments, yet are highly sensitive to water stress, including both flooding and drought. Excess water can lead to stunted growth, leaf chlorosis, and even plant wilting, while drought stress often results in shortened plant height, premature tasseling, reduced pod or ear formation, and ultimately significant yield losses. Therefore, it is essential to regulate water availability according to the specific requirements of each crop growth stage to support optimal development. During critical growth phases—such as seedling establishment, nodulation, tasseling, silking, and grain or pod filling—timely irrigation and drainage interventions should be implemented to meet peak water demand. For early-sown crops, it is advisable to apply "winter protection irrigation" in early January to enhance cold resistance and reduce the risk of low-temperature injury. Given the regional climatic characteristics—such as winter and spring droughts and concentrated rainfall during summer and autumn—proactive measures should be taken to establish and maintain effective field drainage systems, including ditch cleaning and infrastructure reinforcement. These practices ensure that the system can retain moisture during drought and discharge excess water during heavy rainfall, thereby enhancing the resilience of the intercropping system and its capacity to withstand climatic extremes (Ahmed et al., 2020).

Weed control

Weed management in fresh edible corn and edamame strip intercropping systems should adhere to the principles of local adaptability, early intervention, and safe, efficient control, with an emphasis on integrated strategies that combine pre-sowing soil-applied herbicides with post-emergence foliar treatments. When soil moisture conditions are favorable after sowing, pre-emergence herbicide application should be prioritized. It is recommended to apply 96% S-metolachlor emulsifiable concentrate at 100 mL per mu, diluted with water and uniformly sprayed across the soil surface. In cases of excessive rainfall or high soil moisture, substitution with 50% prometryn at 100 g per mu is advised, also applied as a uniform spray. If pre-emergence herbicide application is not feasible or ineffective due to environmental constraints, post-emergence stem and leaf treatments should be promptly implemented. The optimal application timing is when corn is at the 3–At the 5-leaf stage of fresh edible corn, the 2–3 leaf stage of edamame, and when weeds are at the 3–5 leaf stage, post-emergence herbicide application is recommended to control early weed competition (Ahmed et al., 2020, Jin et al., 2024). The following protocols are advised:

Fresh Edible Corn: Apply 5% imazethapyr at 100 mL per mu, or 75% thifensulfuron-methyl at 0.7–1 g per mu

Fresh Edamame: Apply 25% fomesafen aqueous solution at 80–100 g per mu, or Use a combined application of 10% quizalofop-p-ethyl emulsifiable concentrate (20 mL) with 25% fomesafen aqueous solution (20 g) per mu, applied using targeted strip spraying.

Given the distinct pest and disease profiles of fresh edible corn and edamame, strip intercropping systems can disrupt pest and disease cycles commonly associated with monocropping. This spatial diversification helps to lower pest population densities and reduce disease incidence. Nonetheless, it remains essential to follow a prevention-first approach within an Integrated Pest Management (IPM) framework. This involves the combined application of agronomic practices, physical and biological controls, and judicious use of chemical pesticides (Wu et al., 2025, Biszczak et al., 2020).

To minimize pesticide residues in harvested products, biological control agents or low-toxicity biopesticides should be prioritized, particularly after corn pollination and during edamame pod development. The use of high-toxicity or long-residual chemical pesticides should be minimized or avoided entirely during these sensitive growth stages. For chemical applications, the two-step dilution method is recommended to ensure even distribution and effective pest control. Additionally, pesticide rotation strategies—utilizing products with different modes of action—should be implemented to delay or prevent the development of pesticide resistance (Wang et al., 2021).

Integrated pest, disease, and rodent control

At the 5-leaf stage of fresh edible corn, the 2–3 leaf stage of edamame, and when weeds are at the 3–5 leaf stage, post-emergence herbicide application is recommended to control early weed competition. The following protocols are advised:

Fresh Edible Corn: Apply 5% imazethapyr at 100 mL per mu, or 75% thifensulfuron-methyl at 0.7–1 g per mu

Fresh Edamame: Apply 25% fomesafen aqueous solution at 80–100 g per mu, or

Use a combined application of 10% quizalofop-p-ethyl emulsifiable concentrate (20 mL) with 25% fomesafen aqueous solution (20 g) per mu, applied using targeted strip spraying. Given the distinct pest and disease profiles of fresh edible corn and edamame, strip intercropping systems can disrupt pest and disease cycles commonly associated with monocropping. This spatial diversification helps to lower pest population densities and reduce disease incidence. Nonetheless, it remains essential to follow a prevention-first approach within an Integrated Pest Management (IPM) framework. This involves the combined application of agronomic practices, physical and biological controls, and judicious use of chemical pesticides (Feng et al., 2019, Tang et al., 2024).

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Agricultural control

Implementing scientific and rational crop rotation strategies is essential for mitigating the negative effects of continuous cropping. For instance, rotating fresh edible corn with leguminous crops such as edamame or peanuts, or with grass crops like rice, can significantly reduce the accumulation of soil-borne pathogens and pest populations. Such rotations disrupt pest and disease life cycles, enhance soil fertility, and promote system sustainability.

Field sanitation and post-harvest residue management are equally critical. After harvesting fresh edible corn, it is important to promptly remove and properly dispose of plant residues and weeds. These materials should be either deeply buried or safely incinerated to eliminate overwintering habitats of pests and pathogens, thereby lowering their initial inoculum or population pressure in the subsequent cropping season (Hanming et al., 2012, Yao et al., 2017).

Additionally, strengthening field management practices is vital. This includes optimal plant spacing to improve air circulation and light penetration, timely irrigation to prevent soil moisture extremes, and the application of organic fertilizers alongside phosphorus and potassium-based fertilizers. These measures enhance plant vigor and stress resilience, thereby improving resistance to pest and disease pressure and contributing to a more robust and productive cropping system (Li et al., 2023).

Physical control

Take advantage of insects' attraction to yellow by setting up yellow sticky traps in the field to kill them (such as red spider mites). Hang 20 to 30 traps per mu, and make sure the sticky traps are at the same height as the corn leaves. Replace them every 15 to 20 days to significantly reduce the insect population (Iqbal et al., 2019).

Biological control

To promote ecological balance and sustainable pest management, it is essential to encourage and conserve natural enemies such as predatory mites, lacewings, and lady beetles. These beneficial organisms play a critical role in suppressing pest populations. Their presence can be supported by interplanting or bordering crop fields with nectar-producing plants, such as alfalfa and clover, which provide suitable breeding habitats and food resources (Głowacka, 2013).

The use of broad-spectrum insecticides should be avoided during periods of high activity of these beneficial species, as such chemicals can disrupt their populations and ecological functions. Instead, biological control agents should be prioritized. For example, 1.8% avermectin emulsifiable concentrate can be diluted 3,000–4,000 times, or 0.5% matrine aqueous solution can be diluted 800–1,000 times before application. These biologically derived pesticides are effective in controlling target pests while minimizing negative impacts on the environment and natural enemy communities. Adopting these practices contributes to an integrated pest management (IPM) approach that enhances pest suppression, reduces chemical inputs, and supports long-term agroecosystem sustainability (DU et al., 2018, Bibi et al., 2019).

Chemical control

Fresh edible corn

Disease and pest management in fresh edible corn requires the application of targeted chemical controls, following integrated pest management principles to ensure efficacy while minimizing environmental impact.

Leaf Spot Disease: Apply 50% carbendazim wettable powder, 70% thiophanate-methyl wettable powder, or 65% Zineb wettable powder, each diluted 500–800 times with water. Treatments should be applied every 7–10 days, for a total of 2–3 applications, depending on disease severity.

Rust Disease: Use 25% tebuconazole water emulsion, diluted 1:2000, or 25% triadimefon wettable powder, diluted 1:1500–2000. Alternatively, apply 20% tebuconazole + azoxystrobin suspension concentrate at a rate of 20 mL per 667 m².

Aphids: During the heart leaf stage, apply 80% dichlorvos emulsifiable concentrate (diluted 1:1500–2000) or 2.5% deltamethrin emulsifiable concentrate (diluted 1:3000–3500) for effective control.

Corn Borer: For general control, use 2.5% deltamethrin or 20% cypermethrin emulsifiable concentrate, diluted 1:1500–2000. In cases of severe infestation, spot-spray the corn whorl with 20–30 mL of 0.2% emamectin benzoate emulsifiable concentrate or 100 g of 90% trichlorfon crystals per mu, diluted in 30 kg of water. Alternatively, apply 1% phoxim granules or 5% bisultap granules, mixed at a 1:5 ratio with fine soil or sand, and broadcast into the corn tassel area to effectively target larvae.

Red Spider Mites: Apply 22% abamectin + spirodiclofen suspension concentrate, diluted 1:3000–4000, via foliar spraying to suppress mite populations. All pesticide applications should strictly adhere to recommended safety intervals, proper application techniques, and residue management protocols to ensure food safety and environmental protection. Additionally, the rotation of active ingredients with different modes of action is recommended to delay the development of resistance.

Fresh edamame

The major diseases affecting edamame include downy mildew, bacterial spot disease, powdery mildew, and rust.

Downy mildew: Apply 58% metalaxyl mancozeb wettable powder or commercial fungicides such as Yinfa Li.

Powdery mildew and rust: Apply 15% or 25% triadimefon-based pesticides;

Bacterial spot disease: Apply 72% streptomycin or 77% copper hydroxide wettable powder;

For insect pests:

Lepidoptera leaf-feeding pests: Control with lambda-cyhalothrin or avermectin;

Leaf beetle pests: Control with lambda-cyhalothrin;

Stink bug pests: Control with 10% imidacloprid or 20% fenvalerate formulations.

Soil-dwelling pests: Apply 2–3 kg of trichlorfon powder per mu in the seed furrows or mix 2.5–3 kilograms of 5% phoxim granules with 15–20 kg of fine soil and apply around the edamame roots along the ridges.

For pest control, depending on the severity of the infestation, apply 2–3 consecutive sprays, with each application spaced 7–10 days apart, to enhance control effectiveness.

Rodent control

To prevent poisoning of humans and non-target species and minimize environmental contamination, rodenticides with no risk of secondary poisoning should be selected. It is recommended to use small packages (5–10 grams of bait per portion) and bait protection devices (such as bait bottles, cans or buckets) to improve safety and effectiveness.

Timely growth regulation

If edamame growth is excessive, apply 5% paclobutrazol wettable powder at a rate of 25–50 g per mu (as low as 20 g per mu during the seedling stage) during the early flowering stage. Dissolve the powder in 30 kilograms of water and apply as a foliar spray. For corn in the 7–11 leaf stage, plant growth regulators such as diethyl aminoethyl hexanoate can be used at the recommended dosage to control plant height.

Intertillage management

Fresh edamame should undergo 1–2 intertillage operations throughout their growth period. The first intertillage should be carried out when the seedlings emerge and the cotyledons unfold, simultaneously with thinning and final spacing. The intertillage depth should be approximately 3 cm. The second intertillage and soil mounding should be performed before the rows close. Fresh edible corn should be mounded for the first time when the plants reach a height of 30–40 cm, and again during the jointing to tasselling stage to promote root development and enhance resistance to lodging.

TIMELY HARVESTING

Harvesting period for fresh edible corn

The optimal harvesting window for fresh edible corn varies depending on the variety but generally occurs during the milk stage, when kernel moisture content ranges between 66% and 71%. At this stage, the silks of the female ears begin to darken, and the ears exhibit a firm texture upon gentle compression. For most cultivars, the ideal harvesting period is 17–23 days after silking and pollination, with a harvest duration of approximately 6 days to maintain peak quality. In intercropping systems, once the corn ears are harvested, it is essential to promptly remove the remaining above-ground biomass, particularly corn stalks. At this stage, the stems and leaves are still tender, succulent, and nutrient-rich, making them highly suitable as fodder for ruminant livestock such as cattle and sheep. Premature harvesting can result in underdeveloped flavor and insufficient aroma, while delayed harvesting leads to kernel hardening, reduced sweetness, and diminished eating quality. To preserve maximum freshness and sweetness, corn ears should be harvested with husks intact and transported to processing facilities or markets on the same day. Overnight storage should be avoided, as it can accelerate moisture loss and sugar-to-starch conversion, compromising overall quality (Kumar et al., 2015).

Harvesting Period for Fresh Edamame

Accurately determining the optimal harvesting period for fresh edible edamame is essential to ensure product quality, maximize yield, and achieve economic efficiency. Typically, the ideal harvest window occurs approximately 45 days after flowering, when the pods begin to exhibit slight yellowing, over 80% of the seeds are fully developed and plump, and the commercial pod rate exceeds 80%. At this stage, the seeds are tender, and the pods remain fresh and green, marking the peak of edible quality. It is recommended to harvest during the early morning or late evening hours, when ambient temperatures are lower (Daramola et al., 2020). This practice helps to reduce respiration rates, enhance nutrient retention in the seeds, and preserve sensory and nutritional qualities. The optimal harvest period is relatively short, generally lasting only 7–10 days, depending on the variety. Premature harvesting results in immature seeds with high moisture content, poor texture, and reduced yield. Conversely, delayed harvesting leads to seed over-maturation, dehydration, and a marked decline in flavor, tenderness, and marketability (Chen et al., 2020).

Due to their extremely short postharvest shelf life at room temperature—typically 3 to 5 days—both fresh edible corn and edamame are highly susceptible to rapid physiological aging and quality degradation, including flavor loss and texture decline. To preserve freshness and maintain product quality, it is critical that harvested crops be marketed immediately. If immediate sale is not feasible, the products must be rapidly cooled and stored under refrigerated conditions to minimize metabolic activity and delay deterioration (Chen et al., 2020, Ali et al., 2024).

Genetic variance that can be transmitted to the progeny. Finding from another research (Taheri et al., 2018) showed that spike length was reduced when plant undergoes to drought stress. The decrease in no of spikelet's per spike under drought may be due to primordial forming during tailoring stage, or could credited with floating death at terminal and Basel end of the spike during stem extension (Frantová et al., 2022). In actuality, the rate and length of the grain formation period affect grain weight. The presence of environmental challenges like drought stress, particularly during the seed development stage, causes a decrease in the rate and length of grains development, which ultimately results in a decrease in grain weight. In the research conducted by (Bala and Sikder, 2018). Drought reduced the storage capacity of the grain with a decrease in number of cells and starch granules in the endosperm. Grain width was also reduced when drought were imposed during cell division (Frantová et al., 2022).

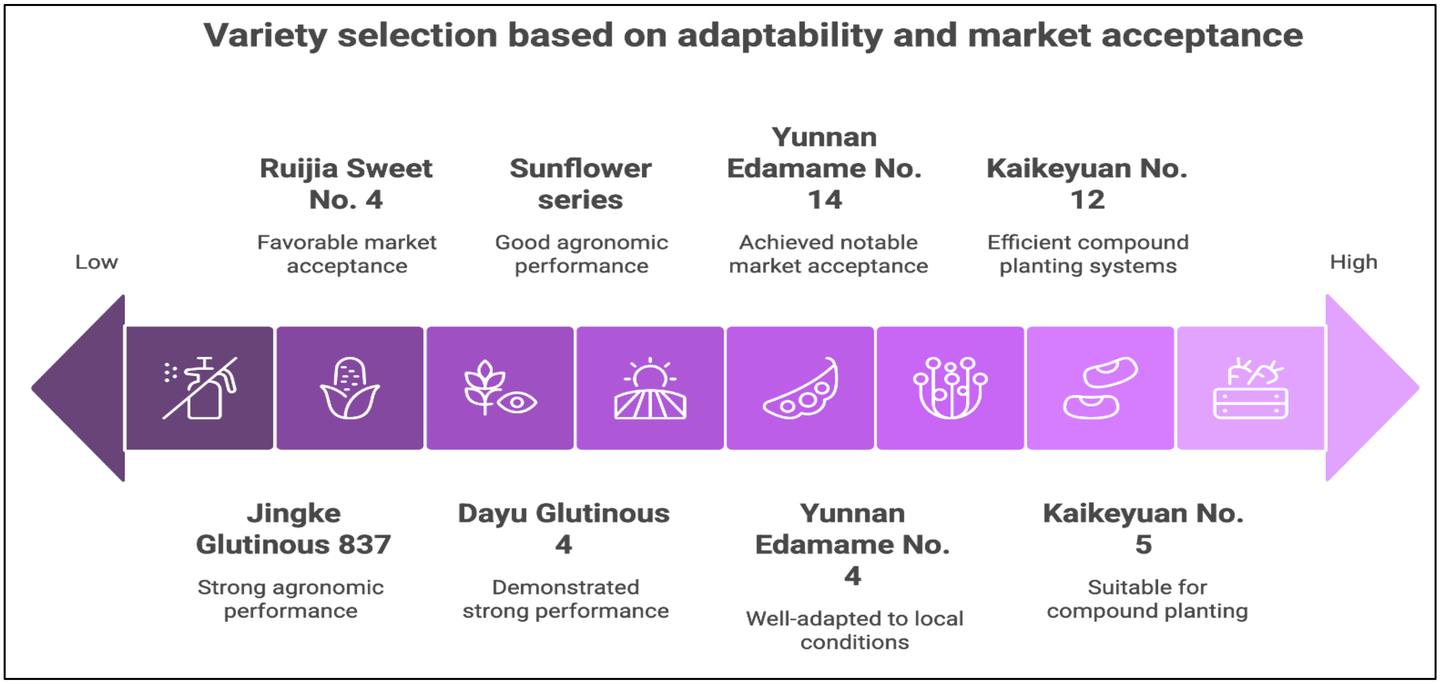

Figure 1: Selection of varieties based on adoptability and market acceptance

Table 1: Summarizing the planting patterns and strip intercropping models for fresh edible corn and edamame

Parameter	Model 1	Model 2	Purpose/Function	Remarks
Total Strip Width	1.8 meters	2.0 meters	To define total planting area width per crop unit	Determines land use layout
Corn Rows per Strip	2 rows	2 rows	Ensures adequate light capture and airflow	Constant in both models
Edamame Rows per Strip	2 rows	3 rows	Enhances legume contribution to soil and crop yield	Affects edamame density
Corn Strip Width	40 cm	40 cm	Allocated space for corn roots and growth	Consistent across models
Edamame Strip Width	30 cm (2 rows @ 30 cm spacing)	60 cm (3 rows @ 30 cm spacing)	Optimizes space for edamame growth and pod development	Denser in Model 2
Inter-strip Spacing	55 cm	50 cm	Promotes light penetration and reduces competition	Narrower in Model 2
System Goal	Balanced growth, spatial optimization	Resource complementarity, efficient spacing	Improve yield, light use efficiency, and microclimate management	Depends on environment and crop traits

Table 2: Summarizing the weed and pest management strategies for fresh edible corn and edamame strip intercropping systems

Aspect	Strategy/Stage	Crop	Recommended Products & Dosage	Remarks
Pre-emergence Herbicide	After sowing (favorable soil moisture)	Both crops	96% S-metolachlor EC, 100 mL/mu (diluted & sprayed)	Use uniformly; alternative: 50% Prometryn 100 g/mu in high moisture conditions
Post-emergence Herbicide Timing	Corn: 3–5-leaf; Edamame: 2–3 leaf; Weeds: 3–5 leaf stage	Both crops	Application timing critical to minimize early weed competition	Apply promptly if pre-emergence herbicides fail
Corn Post-emergence Control	Foliar spray	Fresh corn	5% Imazethapyr 100 mL/mu or 75% Thifensulfuron-methyl 0.7–1 g/mu	Use when corn is well established
Edamame Post-emergence Control	Foliar or strip-targeted spray	Edamame	25% Fomesafen 80–100 g/mu or mix 10% Quizalofop-p-ethyl (20 mL) + 25% Fomesafen (20 g) per mu	Use strip-spray method for precision
Pest & Disease Suppression	Spatial diversification through strip intercropping	Both crops	Disrupts monocrop pest cycles	Reduces incidence of pests and diseases
Integrated Pest Management	Agronomic + physical/biological + selective chemical control	Both crops	Biological agents preferred post-pollination (corn) & pod setting (edamame)	Avoid high-toxicity pesticides in sensitive stages
Residue & Safety Measures	Pesticide rotation + two-step dilution + low-toxicity use	Both crops	Ensures low residues and delays resistance	Rotate active ingredients; follow safety protocols

Application Method	Uniform spray (herbicides); Targeted strip spray (post-emergence)	Both crops	Efficient, minimizes drift and enhances efficacy	Ensures precise coverage

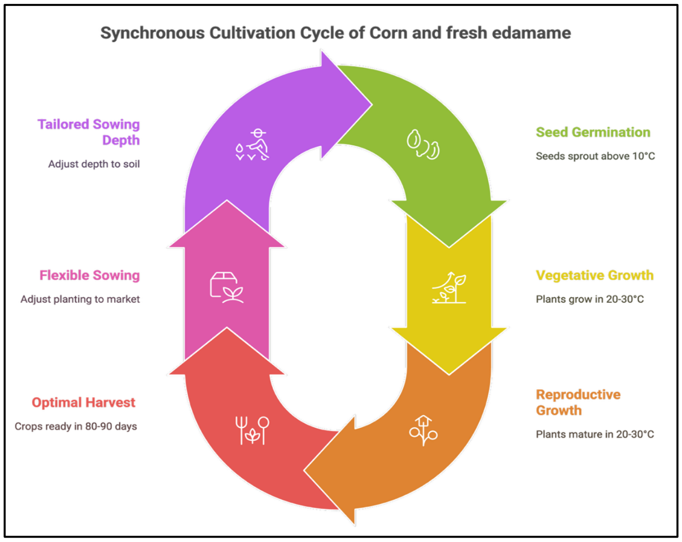

Figure 2: Synchronous Cultivation of corn and fresh edamame

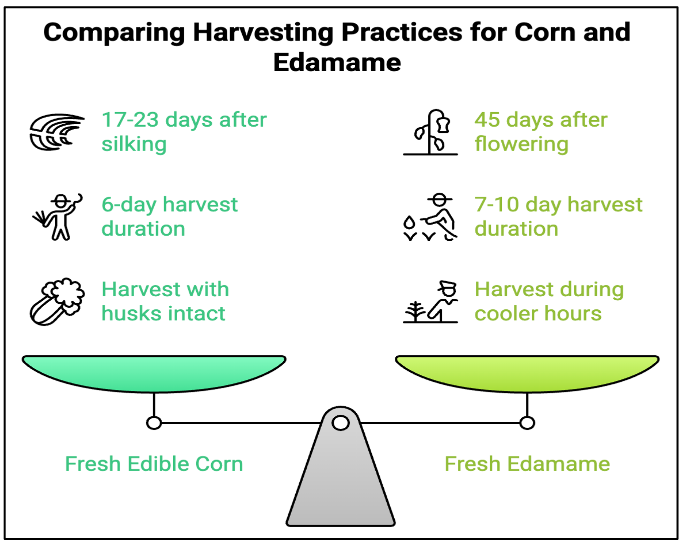

Figure 3: Harvesting Practices for Corn and Edamame

CONCLUSION

This study demonstrates that strip intercropping of fresh edible corn and edamame offers a scientifically robust and practically feasible approach to address challenges in modern sustainable agriculture. The complementary nature of these two crops—corn with high nutrient demand and edamame capable of biological nitrogen fixation—enables efficient resource utilization and reduces fertilizer inputs. Strategically designed planting models improve spatial arrangement, light use efficiency, and microclimate regulation while mitigating pest and disease cycles. Key findings emphasize that optimal system performance requires careful selection of varieties adapted to local agroecological conditions, synchronized sowing and harvesting, and precise nutrient and water management. Integrated pest and disease management strategies that prioritize natural enemies, biopesticides, and resistance-breaking chemical rotations contribute to environmental sustainability. Timely harvesting and post-harvest handling are crucial for maintaining quality and market value, given the short shelf life of both crops. This intercropping system can increase land productivity, stabilize yields, and improve profitability by enhancing soil health and reducing external input requirements. The model aligns with climate-smart agriculture principles, promoting system resilience under fluctuating climatic conditions. As a scalable solution, it holds promise for broader application in diversified cropping systems globally. Future work should explore mechanization compatibility and multi-season optimization to support widespread adoption.

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