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Developing Edible Mushroom Cultivation Through the Use of Local Seeds and the Recycling of Agricultural Waste for a Sustainable National Economy

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Abstract:
Edible mushroom cultivation, based on local strains and agricultural waste recycling, promotes a sustainable economy by reducing reliance on imported mycelium and enhancing local resource use. Despite mushrooms' sensitivity to contamination, production can be improved through resistant strains, optimized substrates, and natural additives. The goals are to increase yields, improve quality, enhance disease resistance, and support sustainable farming. This approach boosts employment, food security, and waste management, contributing significantly to the economic development of rural and peri-urban areas.

Keywords: Mushrooms, cultivation, recycling, waste, sustainability, economic, recovery.
JEL Classification Codes : Q 20, Q23, Q 57

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1. Introduction

The development of edible mushroom cultivation in the Tlemcen region, located in western Algeria, represents a promising opportunity to strengthen the transition toward a sustainable and resilient economy. With its rich agricultural potential, the region generates large quantities of plant waste each year such as straw, olive residues, citrus peels, and other by-products often underutilized or burned, causing negative environmental impacts. Recycling these wastes into growing substrates offers an innovative and ecological solution for mushroom production while reducing pollution.

Moreover, using local mushroom strains adapted to Tlemcen's specific climatic and biological conditions could significantly reduce dependence on costly imported mycelium, which is often poorly suited to local environments. This approach, based on technological self-reliance and resource circularity, fully aligns with a sustainable development strategy.

It offers concrete prospects for creating non-traditional agricultural activities, particularly for youth and women in rural areas. By combining agricultural innovation, environmental protection, and local economic development, mushroom cultivation in Tlemcen can become a key lever for revitalizing the regional economy and contributing to a greener, more inclusive, and resilient national economy.

2. Source of Inspiration and Idea of the Proposed Project

This project aims to promote sustainable agricultural development through an innovative and environmentally friendly approach to cultivating edible mushrooms. It is based on the use of local fungal strains, known as spawn, and converts agricultural waste such as straw, olive pomace, date residues, and pruning waste into nutrient-rich growth substrates.

This initiative follows the principles of a circular economy by reducing pollution caused by open burning or uncontrolled disposal of organic waste, while decreasing dependence on imported mycelium and enhancing national self-reliance.

Locally adapted strains offer greater resilience and lower production costs, making mushroom cultivation accessible to small-scale farmers and rural

entrepreneurs. In addition, incorporating locally available natural inputs, such as date molasses, can improve substrate quality and increase crop yields.
Beyond environmental benefits, this approach delivers significant socioeconomic advantages.

It creates green jobs, improves food security by diversifying protein sources, and supports rural development particularly in regions like Tlemcen, where agricultural waste is abundant but economic opportunities remain limited.

Overall, this model contributes to building a sustainable national economy driven by ecological innovation, efficient resource use, and inclusive growth.

It aligns with key global sustainable development goals, including climate action, responsible consumption, and decent work, positioning mushroom cultivation as a strategic sector for Algeria's sustainable and green future.

3. the causes

Several economic, environmental, and social factors justify the implementation of a project for cultivating edible mushrooms based on the use of local strains and the recycling of agricultural waste.

3. 1. Abundance of unutilized agricultural waste

The Tlemcen region, deeply rooted in agriculture (olives, cereals, fruit trees, and date palms), generates large quantities of plant residues each year. These wastes are often burned in the open or left to decay, causing air pollution, loss of organic matter, and health hazards.

3. 2. Dependence on imported inputs

Most mushroom cultivation in Algeria relies on imported spawn (mycelium), which is expensive and sometimes poorly adapted to local climatic conditions. This dependence hinders the sector's autonomous development and increases the risk of technical failure.

3. 3. Pressure on natural resources and need for sustainability

Faced with climate change, water scarcity, and soil degradation, it has become essential to develop sustainable agricultural practices that are low in

resource consumption. Mushroom cultivation, which requires little water and can be carried out on small surfaces, represents a promising alternative.

3. 4. Unemployment, especially in rural areas and among youth

Unemployment rates, particularly high in rural and peri-urban areas of Tlemcen, call for the creation of accessible new economic sectors. Mushroom farming requires limited initial investment and can be adopted by youth, women, and smallholder farmers.

3. 5. Food insecurity and the need for local protein sources

Algeria imports a significant portion of its food needs, especially protein. Edible mushrooms are a rich plant-based source of proteins, fiber, and micronutrients, offering a contribution to healthy and locally produced diets.

3. 6. Lack of agricultural diversification

The local agricultural economy remains heavily reliant on a few traditional sectors. Mushroom cultivation offers a diversification opportunity compatible with family farming and small-scale operations.

These converging factors demonstrate that developing a local edible mushroom sector is not merely a technical innovation, but an integrated response to the environmental, economic, and social challenges facing the region.

4. The Potential of Edible Mushroom Cultivation in the Tlemcen Region

The Tlemcen region, endowed with a rich agricultural and natural heritage, stands at a strategic crossroads between traditional farming practices and the pressing need for sustainable modernization.

In this context, the cultivation of edible mushrooms emerges as an innovative, ecological, and economically viable solution to address the region's multiple challenges.

Tlemcen generates significant quantities of agricultural waste each year cereal straw, olive residues, citrus peels, winemaking pomace, and by-products from date palm cultivation. Often burned or left unused, these biomass materials represent not only a source of pollution but also an underutilized resource.

Yet, they serve as ideal substrates for growing mushrooms such as *Pleurotus spp.* (oyster mushrooms) or *Agaricus bisporus*, whose mycelium efficiently breaks down cellulose and lignin.

Mushroom farming (myciculture) offers exceptional advantages for local development: it requires minimal space, can be carried out in controlled environments (such as caves, shelters, or unused buildings), consumes very little water, and allows for rapid production cycles (4 to 8 weeks).

It is therefore particularly well-suited to rural and peri-urban areas, where access to land, water, and agricultural infrastructure remains limited.

One of the main current challenges is the dependence on imported mycelium strains, which are costly and often poorly adapted to Tlemcen's humid Mediterranean climate. Developing locally selected and propagated strains is a crucial pathway to ensure autonomy, resilience, and lower production costs. Moreover, the use of natural local additives such as date molasses, stimulate fungal growth, and enhance the organoleptic quality of the harvest.

From a socio-economic perspective, the mushroom sector holds significant potential for creating green jobs, especially for young graduates, rural women, and aspiring farmers with limited capital. It promotes diversification of agricultural activities, reduces post-harvest losses through waste valorization, and contributes to food security by providing a local source of protein, fiber, vitamins (B, D), and antioxidants.

Mushroom cultivation in Tlemcen is far more than a minor agricultural niche it is a lever for territorial transformation. By combining innovation, environmental sustainability, and social inclusion, it has the potential to become a cornerstone of modern, ecological, and resilient rural development in Algeria. Furthermore, this activity fully aligns with a low-carbon circular economy, closing the loop between agricultural production, waste management, and value creation. It can be integrated into agro-ecological models, urban farms, or rural cooperatives, supported by accessible technical training programs.

5. Wild and Cultivated Edible Mushrooms in the Tlemcen Region

The Tlemcen region, characterized by a humid Mediterranean climate, oak and pine forests, extensive farmland, and rich plant biodiversity, offers favorable ecological conditions for the presence of edible mushrooms, both wild and cultivated.

5. 1. Wild Edible Mushrooms

During autumn and spring, following regular rainfall, numerous species of wild mushrooms naturally emerge in the forested areas of Tlemcen. Among the most commonly observed species are:

- ***Boletus edulis*** (porcini or cep): Highly prized, grows at the base of oak and beech trees.
- ***Cantharellus cibarius*** (chanterelle): Found in forest edges, appreciated for its delicate flavor.
- ***Lactarius deliciosus*** (saffron milk cap): Associated with pine trees, frequently harvested locally.
- ***Macrolepiota procera*** (parasol mushroom): A common saprophytic mushroom found in meadows and clearings.

These mushrooms are traditionally collected by rural inhabitants for both household consumption and informal sale in local markets. However, this practice remains largely unstructured, lacking sanitary oversight or industrial valorization. It also carries risks of misidentification, which can lead to poisoning.

5. 2. Cultivated Edible Mushrooms

In response to growing demand for healthy and locally produced food, mushroom cultivation is gradually gaining ground in Tlemcen. Although still in its early stages, individual initiatives and pilot projects have emerged, particularly in peri-urban areas such as Aïn Fezza, Aïn Youcef, and El Fehoul.

The main cultivated species include:

- ***Pleurotus ostreatus*** (oyster mushroom, grey or yellow): The most widespread species, easy to grow on substrates such as straw, sawdust, or agricultural residues.
- ***Pleurotus eryngii*** (king trumpet mushroom): More demanding to cultivate but has high market value.

- ***Agaricus bisporus*** (button mushroom): Grown under controlled conditions, typically in greenhouses or climate-controlled rooms.

The substrates used are primarily derived from local agricultural waste: cereal straw, olive pomace, date palm residues, citrus peels, and similar by-products. Recycling these materials into mushroom cultivation perfectly illustrates the principles of a circular economy.

5. 3. Challenges and Prospects

The coexistence of wild and cultivated mushrooms in Tlemcen opens up several promising opportunities:

- **Valorization of natural mycological heritage**: Encouraging research, conservation, and awareness of fungal biodiversity.
- **Development of a local mushroom sector**: Establishing cooperatives, providing technical training, and promoting safe, hygienic production.
- **Safer wild harvesting**: Educating collectors about poisoning risks and providing expert guidance.
- **Agricultural innovation**: Integrating mushroom farming into existing farms to diversify income sources.
- **Mycological tourism**: Potential to develop eco-tourism trails centered on wild mushroom foraging and education.

In Tlemcen, edible mushrooms whether wild or cultivated represent an underappreciated resource with multiple dimensions: ecological, nutritional, economic, and cultural. Their sustainable development, combining biodiversity conservation and agricultural innovation, could significantly contribute to the transition toward sustainable agriculture and a green economy rooted in local resources.

6. Reproduction Cycle and Morphology of a Mushroom

Mushrooms are living organisms belonging to the *Fungi* kingdom, distinct from plants and animals. Their structure and reproductive mechanisms are adapted to a primarily decomposer lifestyle, playing a crucial role in the recycling of organic matter.

6. 1. Morphology

A mushroom consists of two main parts:

- The mycelium, a network of microscopic filaments (hyphae) that penetrates the substrate (wood, soil, organic waste) and absorbs nutrients. This is the vegetative part, invisible to the naked eye and the most extensive component.
- The fruiting body (the visible "mushroom"), composed of a cap, gills, and a stem, whose primary function is to produce and disperse spores.

6. 2. Reproduction Cycle

Reproduction can be asexual or sexual, but in edible mushrooms (such as oyster or button mushrooms), it is predominantly sexual:

1. Spores are released and germinate to form a primary mycelium.
2. Two compatible mycelia fuse (plasmogamy), forming a dikaryotic mycelium (two nuclei per cell).
3. Under favorable conditions (humidity, temperature), this mycelium develops into a fruiting body.
4. Inside the gills, the nuclei fuse and undergo meiosis, generating new spores that restart the cycle.

This cycle, based on airborne spore dispersal and organic matter decomposition, explains the efficiency of mushrooms in natural ecosystems and their great potential in sustainable agriculture. In mushroom farming (myciculture), understanding this cycle enables controlled cultivation using selected strains grown on recycled substrates such as in development projects in Tlemcen.

7. Mushroom Cultivation to Strengthen Food Security

Through this initiative, this work aims to promote innovative production of edible mushrooms in Algeria as a means to strengthen food security. The project benefits from the support of academic and economic institutions, including Abou Bekr Belkaid University and the Agricultural Chamber of Tlemcen Province.The project is built on three major innovations that directly contribute to improving mushroom production and, consequently, food security:

7.1. Enhancing Cultivation Using Local Products

The project proposes enriching growing substrates (derived from recycled agricultural waste) with a natural and locally abundant product date syrup. This innovation aims to:

- Replace costly or imported additives.
- Improve the quality, growth, and nutritional content of mushrooms.
- Reduce contamination risks.
- Add value to a local agricultural by-product (date syrup), thereby strengthening national self-reliance.

Results show a significant improvement in mushroom quality and biomass, while reducing pollution and production costs. This makes the product more accessible in the national market and stimulates the rural economy.

7.2. Valorization of Local Strains and Recycling of Agricultural Waste

The project emphasizes:

- The use of local fungal strains adapted to the region's climatic conditions.
- The recycling of agricultural waste (straw, olive pomace, coffee residues, etc.) into growth substrates for species such as *Pleurotus* (oyster mushroom) and *Agaricus bisporus* (button mushroom).
- Reduce dependence on imported strains.
- Promote sustainable and environmentally friendly agriculture.
- Embody the principles of the circular economy: waste becomes a resource.
- After harvest, the spent substrate can be reused as a rich organic fertilizer containing nitrogen, potassium, and organic matter.

This process increases the availability of nutritious and affordable protein sources for the population.

7. 3. Implementation of an Intelligent Climate Management System

An automated system has been developed to monitor and control cultivation conditions:

- Real-time monitoring of temperature, humidity, and ventilation via sensors and a control unit.

- Optimization of growth conditions.
- Reduction of losses due to inefficient manual management.
- Improvement of profitability and production consistency.

Thanks to this system, production becomes more stable and predictable, ensuring a continuous supply of fresh mushrooms on the market, thus reinforcing food security.

7. 3. 1.General Objectives of the Project

- Increase yield.
- Improve mushroom quality.
- Enhance disease resistance.
- Optimize the use of local resources.
- Promote sustainable production.

7. 3. 2. Socio-Economic and Environmental Impact

- **Job creation**, especially in rural and peri-urban areas.
- **Diversification of agricultural income**.
- **Reduction of unemployment**, particularly among youth.
- **Food security**: access to a local, healthy source rich in proteins, fiber, vitamins, and minerals.
- **Positive environmental impact**: waste valorization, reduced pollution, low water and energy consumption.
- **Rural development**: stimulation of the local economy through a low-space, low-capital activity.

7. 3. 3.Technical and Commercial Aspects

- Cultivation techniques: use of substrates based on straw, horse manure, olive pomace, etc., under precise conditions (pH 7.2–7.8, temperature 25–27 °C).

- Government support: access to financial assistance through agencies such as ANSEJ, CNAC, ANGEM, and ANDI, which offer loans, tax exemptions, and technical support.

Marketing and commercialization:

- Creation of a brand for fresh mushrooms.

- Compliance with food labeling regulations (Executive Decree No. 03-09 of February 25, 2009).
- Mandatory Arabic labeling (with optional bilingual format), including: product name, net weight, expiration date, nutritional value, barcode, and producer contact details.
- Development of distribution channels: supermarkets, restaurants, hotels, and e-commerce.
- Awareness campaigns on the nutritional and medicinal benefits of mushrooms (antibacterial, antitumor, etc.).

7. 3. 4.Competitive Advantages of the Project

Low environmental impact: no pollution, minimal water and energy use.

- Use of agricultural waste as raw material, reducing costs.
- Local production, decreasing dependence on imports.
- Technological innovation: use of date syrup and intelligent control systems.
- High nutritional value of mushrooms, ideal for dietary diversification.

7. 3. 2. Identified Challenges

- Sensitivity to environmental conditions (humidity, temperature, contamination).
- Perishable product: need for effective conservation systems.
- Need for technical training for producers.
- Cost of certain inputs (imported mycelium, equipment).
- Potential competition with cheaper imported mushrooms.
- Risks of fungal or bacterial diseases.

7. 3. 3.Development Perspectives

- **Research Support :**
  - Development of improved local strains.
  - Creation of specialized research centers.
  - Collaboration between universities, startups, and farmers.
- **Access to Technology:**
  - Financial support for acquiring automated systems.
  - Establishment of pilot farms for training.
- **Training Programs :**

- Technical workshops for farmers.
- Creation of agricultural cooperatives.

- **Economic Sustainability :**
  - Use of agricultural and industrial waste.
  - Valorization of spent substrate as organic fertilizer or animal feed.
- **Government Support :**
  - Financing policies and low-interest loans.
  - Provision of land for mushroom farms.
  - Technical and informational support.

7. 3. 4.Impact Assessment and Monitoring

- Monitoring through key performance indicators (production volume, sales, market share, new enterprises, jobs created, awareness levels).
- Regular surveys of consumers and producers.
- Periodic reports on progress and challenges encountered.

This initiative illustrates an integrated and innovative approach to developing edible mushroom cultivation in Algeria. By combining local resource valorization, smart technologies, and sustainable practices, it aims to generate positive social, economic, and environmental impacts.

Mushroom cultivation is more than just an agricultural activity it represents a strategic lever to strengthen food security, create green jobs, and stimulate rural development, all within the framework of an inclusive and ecological transition.

8. Conclusion

Edible mushroom cultivation in Algeria, particularly in agriculturally rich regions such as Tlemcen, is far more than a marginal or supplementary activity. It has emerged as an integrated, sustainable, and innovative solution to pressing strategic challenges: food security, rural development, organic waste management, and green job creation. In a context marked by demographic pressure, the scarcity of natural resources, and dependence on food imports, myciculture is becoming a key lever for food sovereignty and territorial resilience.

The proposed approach based on the use of local fungal strains, the recycling of agricultural waste (straw, olive pomace, date residues, citrus peels, etc.), and the enrichment of growth substrates with locally available natural products like date syrup demonstrates that it is possible to produce safe, nutritious, affordable, and environmentally friendly food.

This model fully embodies the principles of a circular economy: waste from one sector (olives, cereals, date palms) becomes the raw material for another, generating value where none previously existed.

The integration of intelligent climate control systems, equipped with temperature, humidity, and CO_2 sensors linked to automated control units, allows for optimized growing conditions, reduced losses due to contamination or poor management, and ensures regular, high-quality, and profitable production.

This automation makes mushroom farming accessible even to inexperienced entrepreneurs, while guaranteeing market supply stability essential for food security.

Multiple and Lasting Impacts

The benefits of this activity are diverse, profound, and interconnected:

- **Social Impact**:

  Mushroom cultivation requires minimal space and initial capital, making it accessible to youth, rural women, unemployed graduates, and smallholder farmers. It promotes economic empowerment, local entrepreneurship, and socio-professional integration, especially in peri-urban areas such as Tlemcen, Aïn Fezza, and El Fehoul.

- **Economic Impact**:

  It stimulates the local economy by reducing dependence on imported mycelium and fresh mushrooms (often from Spain or France). It fosters the creation of micro-enterprises, cooperatives, and short supply chains. By adding value to agricultural by-products, it lowers production costs and improves farm profitability.

- **Environmental Impact**:

By transforming organic waste into resources, myciculture helps reduce pollution (from open burning, soil and water contamination) and drastically cuts water consumption up to 90% less than traditional crops while minimizing energy use. After harvest, the spent substrate becomes a rich organic fertilizer high in organic matter, nitrogen, and potassium, suitable for use in horticulture or arboriculture.

Development Perspectives: Toward a Structured Sector

To sustain and amplify these benefits, it is essential to transition from isolated initiatives to a structured and supported sector. Several strategic levers must be activated :

- Strengthening Research and Innovation

- Establish a regional center for applied mycology in Tlemcen, in partnership with Abou Bekr Belkaid University, to select, conserve, and multiply high-performing local strains (*Pleurotus spp.*, *Agaricus bisporus*).
- Launch research programs on substrate enrichment (using date syrup, by-product flours, etc.) and preservation techniques (dehydration, pasteurization).
- Explore value-added derivatives: dried mushrooms, bioactive extracts (antioxidants, polysaccharides), dietary supplements, and cosmetic applications.

- Institutionnel and Policy Support

- Develop a national strategy for myciculture development, integrated into food sovereignty and green economy plans.
- Implement financial and tax incentives through agencies like ANSEJ, CNAC, ANGEM, and ANDI offering zero-interest loans, equipment subsidies, and tax exemptions.
- Allocate agricultural or industrial land for collective or cooperative mushroom farms.

- Training and Knowledge Transfer

- Integrate myciculture into vocational training programs (CFPA, CFP) and university curricula (agronomy, biotechnology).

- Develop pilot farms in Tlemcen and other provinces, open for visits, internships, and hands-on training.
- Create a national network of producers to share best practices, pool purchases, and access markets.

- Commercialization and Marketing

- Promote local brands (e.g., *Terroir Tlemcen*, *FungiDZ*, *Champ'Olive*) to differentiate Algerian mushrooms in the marketplace.
- Develop modern distribution channels: short supply chains, organic markets, e-commerce, and home delivery.
- Raise public awareness through nutritional education campaigns highlighting the health benefits of mushrooms (plant-based protein, vitamin D, fiber, antitumor properties).

- Transition to a Local Bioeconomy

- Integrate mushroom farming into agro-ecological farms combining horticulture, livestock, and waste recycling.
- Use spent substrate not only as fertilizer, but also as animal feed or raw material for bioenergy production (biogas via methanization).
- Encourage multi-sector cooperatives where waste from one farm becomes a resource for another.

Edible mushroom cultivation in Algeria especially in Tlemcen is far more than a simple agricultural project. It represents a model of inclusive and sustainable development, capable of turning waste into wealth, youth into entrepreneurs, and underutilized land into productive farms.

By combining technological innovation, local resource valorization, and ecological commitment, it paves the way for a new Algerian agriculture resilient, green, and deeply rooted in local realities.

The future of Algerian agriculture lies not only in cereal fields and olive groves, but also in these small, humid spaces where mushrooms grow
discreet yet powerful symbols of a profound and necessary transformation.

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