

# CHALLENGES OF ORGANIC AGRICULTURE FOR THE PRODUCTION OF COMPOSTS AND VERMICOMPOST FOR THE PRODUCTION OF MEDICINAL PLANTS – A SOCIOECONOMIC DEMAND

## *DESAFIOS DA AGRICULTURA ORGÂNICA NA PRODUÇÃO DE COMPOSTO E VERMICOMPOSTO NA PRODUÇÃO DE PLANTAS MEDICINAIS: UMA DEMANDA SOCIOECONÔMICA*

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**ABSTRACT:** Although the demand for organic fertilizers in agriculture is growing, it remains incipient in some production sectors, such as medicinal plant production, which does not possess specific technology for its development. Solid residues are highly contaminant to water sources, soil, populations and biodiversity but can potentially be used to produce organic composts and vermicompost, such production not only enables nutrient recycling but also acts on soil conditioning, increasing soil organic matter and improving its physical, chemical and biological characteristics, as well as strengthening organic production with an emphasis on medicinal plant production. In this context, recommendations for and applications of organic fertilizers available in the market were reviewed; in addition, the imminent socioeconomic demand for organic compost and vermicompost production was contextualized based on residues from coffee and sugarcane production and cattle farming for application to the medicinal plant production chain. It is concluded that although these sectors produce a considerable amount of residues, they are not being reused in formulation of organic composts and vermicompost, and commercial organic fertilizers recommended for medicinal plant production were not found. Thus, the formulation of vermicomposting and composting from the reuse of agricultural residues, are potential social, economic technologies and tools to be valued and disseminated to traditional and family farmers.

**KEYWORDS:** Agroecology. Horticulture. Secondary metabolism. Solid residues. Sustainability.

### INTRODUCTION

Medicinal plants play an important role in health maintenance and comprise the most accessible treatment for 80% of the population (SOUZA-MOREIRA, 2010). The medicinal plant sector is a promising market, with revenue of approximately US\$ 160 million/year in Brazil, and medicinal plants are its raw material (RODRIGUES,

2010; LOPEZ-GONZALEZ et al., 2013; JIANG et al., 2016).

Agricultural and animal farming residues, when disposed of inadequately and in a disorderly manner, have environmental impacts because of the generation of large quantities of contaminants, such as feces, toxic metals, inorganic salts, pathogens, lixiviation and toxic gas emission, especially in containment systems (ERTHA 2010; LIMA et al.,

the cultivation of medicinal plants demands care, since they are used for therapeutic purposes, and organic practices are therefore of interest. Accordingly, the use of organic composts and vermicompost in agriculture is of great relevance, since it is associated with care for the environment (SANTOS et al., 2014; WU et al., 2014; COTTA et al., 2015) being beneficial for biodiversity, environment, fauna and consumers, which have a high demand for products that are free from chemicals and/or genetic modification (WILLER,

nutrient immobilization by microorganisms, and contamination of water reserves (SILVA, 2008). However, these residues can potentially be used in the formulation of vermicompost and organic composts that can be applied to medicinal plant production (WU et al., 2014; MORAES, 2015; SOARES et al., 2017).

Recommendations for organic composts and vermicompost for medicinal plant cultivation that may result in both biomass gain and increased concentrations of bioactive compounds with pharmacological and biological interest remain

incipient. Therefore, the aim of this review was to contextualize the importance of reusing agricultural and animal farming residues to produce organic composts and vermicompost aimed at the production of medicinal plants and active compounds of pharmacological and biological interest.

## DEVELOPMENT

The bibliographic research was carried out by compiling publications on agricultural bases indexed on free access digital platforms that work with the commercialization of organic fertilizers. The companies evaluated in this research were (1) Terra Fértil; (2) Plantei; (3) NutriSafra; (4) MfRural; (5) Neudfor; (6) Agrobio; (7) Folhito Mix; (8) Fish fértil; (9) Microbio. The total of 33 organic fertilizers made available by these companies were listed and the analysis and systematization of the commercial name, composition and agricultural recommendation of organic fertilizers for the crops of interest were made.

### Factors determining the stagnation of medicinal plant production

The establishment of agricultural production chains is not an isolated factor within the economic development of countries; there are socioeconomic and historical processes intrinsic to the production of food, goods and services (SOUSA; GOIÁIS, 2015). In this context, changes in agriculture began with the Green Revolution and culminated in the economic globalization that began in the 1990s; this globalization was organized around large companies, agricultural industries and multinationals that control the world market LAZZARI; SOUZA, 2017; MATOS; PESSOA, 2011). Ever since the colonial period, an essentially organic based-agriculture has been replaced by techniques that depend on chemical inputs, whereas the Brazilian agricultural policy prioritizes incentives to commodity export (FLORES; GREGORI; ARAÚJO, 2013; PEREIRA; SOUSA, 2016; GURGEL; GIRALDO, 2017) with agribusiness justifying production chains that have the goal of gathering agrochemical, industrial and commercial activities and land monopolies and directing them toward the external market (SAUER; LEITE, 2012; MENDONÇA, 2015).

To establish agriculture and animal farming, it has been necessary to standardize cultivation and to industrialize and optimize production chains, which are essential factors in the expansion of agribusiness at an international level, consolidating

the standard food production model in Brazil (SAMPAIO; NETO, 2018).

In parallel with the green revolution, the industrial revolution promoted the industrialization of the countryside, which had strong environmental impacts caused by the intensive use of fossil fuels (PEREIRA; SOUSA, 2016; SAMPAIO; NETO, 2018). In this context, the pharmaceutical industries developed side by side, comprising the hegemonic production model of “disease and cure” and contributing to the irrational use of agrotoxics and drugs as a way of maintaining profit and hegemony (MONTEIRO; LACERDA, 2016; MENDONÇA et al., 2015; BARROS, 2018).

Therefore, although populations have historically used medicinal plants, after the industrial revolution, natural products were replaced by synthetic drugs on a massive scale. The New Chemical Entities of pharmaceutical products recorded that at least 27% of synthetic drugs originate from plant biodiversity and are formulated from natural products via chemical synthesis (ALVES; PONTES, 2017). Therefore, there is a deficit in the development of services, technologies and research related to medicinal plant production in Brazil (TORRES, 2015).

The stagnation observed in medicinal plant production is caused by the fact that food, natural products and drug production are not foreign to societal factors but instead depend on political and economic interests (RONDÓ; LOPES, 2016). In this scenario, medicinal plant production was not historically recognized as an agricultural production chain or as having political and economic interest; it only reemerged as potent and innovative in the 2000s (PIMENTEL, 2015). Accordingly, there is an imminent demand for technologies and research in medicinal plant production (HEINZMANN; BARROS, 2007; RIBEIRO et al., 2014; ASSIS; MORELLI-AMARAL; PIMENTA, 2015).

### The Brazilian scenario of medicinal plant and herbal drug production: expanding demand

The use of medicinal plants in popular medicine in Brazil, especially by traditional peoples (Quilombolas, Native Peoples, Riparian Communities), is historically expressive and has been exploited by Brazilian researchers and the pharmaceutical industry (CALIXTO; SIQUEIRA, 2008; LIRA; CHAVES, 2015). The interest in plant-derived drugs, especially from medicinal species, is growing worldwide given that 30% of the available therapeutic drugs are either directly or indirectly derived from natural products (KOEHN; CARTER,

2005; LIMA; GOMES, 2014; MENDONÇA et al., 2018).

Brazil is the country with highest biodiversity in the world, with an estimated over 50,000 species of higher plants (20-22% of the total worldwide), along with mammals, birds, insects and microorganisms (RODRIGUES, 2016). The use of medicinal plants by the population through living pharmacies and phytotherapy (TORRES, 2015) are essential to meet this demand (ARAÚJO et al., 2013) Brazilian revenue from this sector is approximately US\$ 160 million per year, constituting a promising market whose raw materials are medicinal plants (RODRIGUES, 2016).

The high profitability of herbal drug production contradicts the myth by the synthetic pharmaceutical industry that this market is of little economic importance (CARVALHO et al., 2011). In addition, the implementation of RDC 26/2014, regulating "Traditional Phytotherapy Products", contributed to the sector's development, demanding advances to establish the production chain.

Medicinal plants (native and exotic) and their derivatives are used by the Brazilian population and are among the main therapeutic resources for the traditional and complementary/alternative medicine (TM/CAM) used in primary health care, according to a diagnostic by the Ministry of Health (MACEDO, 2016). This enables the appearance of new opportunities for the creation of production cooperatives both in traditional communities and in companies.

According to Marques et al., 2007, establishing policies for medicinal plants and herbal drugs depends on multiple investments in their production chain, namely, by universities and companies (MACEDO, 2016) from the plant to the final product. In this sense, technologies need to be developed that support medicinal plant production from farms to processing units and/or industry. Therefore, there is a socioeconomic demand for investment in medicinal plant production chains from cultivation to processing to advance the national pharmaceutical industry, which depends on the supply of raw material at an industrial scale to develop herbal and natural drugs with safety, efficacy and quality certification; such drugs demand fewer resources and have lower risks than synthetic drug production (CALIXTO et al., 2000; LOPES; NASCIMENTO, 2017; LIMA, 2015; MATOS, 2016).

Drug production is therefore an essential factor of national sovereignty and safety (PADULA, 2017). However, because of socioeconomic and

political factors, despite its biodiversity, Brazil still depends on raw material produced by multinationals from developed countries such as USA, China, Israel, Korea and India (CALIXTO, 2000; KOEHN; CARTER, 2005). Given this scenario, for the last 15 years, the Ministry of Health has invested in public policies to promote and consolidate medicinal plant production and strengthen the national pharmaceutical industry. Some of these national policies were the National Policy of Integrative and Complementary Practices - National Policy of Integrative and Complementary Practices – PNPIC (PERFEITO; ANDREOTTI, 2019), the National Policy of Medicinal Plants and Herbal Drugs (National Policy on Medicinal Plants and Herbal Medicines, 2006) and the National Program of Medicinal Plants and Herbal Drugs (National Program for Medicinal Plants and Herbal Medicines – PNPMPF).

The public policies mentioned above established important decrees for productive advancement, such as RDC nº 60 (2011), approving the Herbal Drugs Form of the Brazilian Pharmacopoeia, which contains 83 herbal drug monographies, and RDC nº 13 (2013) of Good Practices for Traditional Herbal Drug Production and the National Drug List (2014).

The National Sanitary Surveillance Agency (ANVISA) regulates the analysis of agrochemical residues in the Brazilian Pharmacopoeia, but residues of undesirable and undeclared substances such as pesticides, radioactive materials, pathogens, mycotoxins, heavy metals and arsenic remain present in plant and herbal drugs (BRASIL, 2011). The PNPMPF guidelines establish actions with the aim of promoting technological, economic and social development that require articulation between institutions to stimulate and consolidate the production complex.

The Local Productive Arrangement, which is aimed at strengthening the implementation of this public policy and includes stages from input production (cultivation/management) to industrialized herbal drug production, shows the innovation, economic, technological and social potential of industrialized herbal drugs (TORRES, 2015), and considers family farming one of the main components of this production chain.

In this context, establishing a medicinal plant production chain remains an imminent demand, requiring basic studies from production of inputs to be used in plantations to evaluations of the active components present in the planted species, with the aim of meeting the safety and efficacy

criteria for medicinal plant and herbal drug production.

### **Organic production panorama in Brazil**

According to the International Federation of Organic Agriculture Movements (IFOAM), organic production systems are still expanding. Organic production occupies approximately 35 million hectares worldwide, especially in Europe (8.2 million hectares), Latin America (8.1 million hectares – Brazil and Argentina), the USA, Japan and Australia. It is practiced in 150 countries, mostly on family farms (WILLER; KILCHER, 2010).

This expansion is related both to environmental problems and food contamination caused by conventional and industrial agriculture and to the fact that organic-based agriculture is beneficial to biodiversity, environment, fauna and consumers, who have a high demand for products that are chemical free and/or not genetically modified (WILLER; KILCHER, 2010).

According to the 2009 Agricultural Census, organic producers in Brazil represented 1.8% (or 90,497) of total agricultural farms. The main areas of development are cattle and other animal breeding (41.7%), temporary plantations (33.5%), permanent plantations that include fruit trees and coffee (10.4%), horticulture/floriculture (9.9%) and forestry (3.8%) (SALVADOR, 2011).

According to the 2006 IBGE Census, approximately 1.7 million hectares are estimated to be under organic management in Brazil (SALVADOR, 2011) with most farms being small, of family origin, and concentrated in the states of Bahia (15,194), Minas Gerais (12,910), Rio Grande do Sul (8,532) and Paraná (7,527).

Although organic production is growing, especially in Brazil, it still faces great difficulties related to public policies, lines of credit, commercialization, investment in specialized technology for input and seed supply, infrastructures, and agro-industries, all of which are factors that affect scale production (WILLER; KILCHER, 2010; ASSIS; MORELLI-AMARAL; PIMENTA, 2015).

In addition, agricultural research has been inefficient in responding to the needs of the organic production system, with the challenge of production expansion being related to research investment, development and technological innovation. Science making and ways of knowledge generation that are not segmented according to the “agrobusiness” development model (conventional agriculture

centralized in multinationals) need to be reevaluated.

### **Agricultural and animal farming residues**

According to a report from the Institute of Applied Economic Research (NOGUEIRA et al., 2015), in 2009 an estimated 291 million tons of residues were generated by agro-industry associated with agriculture, and approximately 1.7 billion tons of waste were generated by animal farming, which are contaminant sources because of their greenhouse gas emissions and nitrogen release into the soil and water (ORRICO JÚNIOR; ORRICO; JÚNIOR, 2009).

Composting is the most effective, alternative and adequate method of solid organic residue treatment for agricultural use (COELHO et al., 2011; LASHERMES; BARRIUSO; HOUOT, 2012). It reuses residues and contributes to environmental conservation, addressing economical and financial questions (NASCIMENTO; FRANCO, 2015) through the generation of new products demanded for agricultural production.

The agricultural and animal farming sector is vast, resulting in high production and availability of residues, both of plant (e.g., coffee straw, sugarcane bagasse, vinasse, saw dust, cakes) and of animal origin (e.g., cattle, horse, pig and poultry manure). In Brazil, the production of these agricultural and animal farming byproducts is distributed per region, which facilitates their reuse for organic compost production.

The main agriculture and animal farming production chains in Brazil are centered on coffee, dairy cattle and sugarcane production. In 2017, the coffee harvest was 45.5 million bags, 79% of them Arabica coffee; dairy production increased 3%, with 34.5 billion liters; and sugarcane production increased 2.3% in 2016/2017, an increase rate that should result in a production of 45.5 million tons in 2026/27 (NASCIMENTO FILHO; FRANCO). This affects the organization of lines of credit, available technologies, and production areas.

### **Market analyses of organic composts and vermicompost recommended for medicinal plant production**

In Brazil, agribusiness is well developed in terms of goods, products, research and technological services applied to agriculture and animal farming. However, because of the technological packages derived from the Green Revolution, research and technologies are directed at meeting the interests of big companies and multinationals, directly affecting the development of technologies that contribute to

advances in agroecology, organic production, traditional knowledge, and other sectors of organic production (LAZZARI; SOUZA, 2017).

The internal market is stable in terms of demand for mineral fertilizers, insecticides, fungicides and other products destined for conventional agriculture. However, other agricultural sectors require standardized and certified products regarding their application and recommendation for unconventional agricultural production. Of the production sectors focused on agroecology and its components, the best-established production chains are those of big crops, fruit trees and horticulture, and although few, there are some products available to establish such crops in the field.

For medicinal plant production, which is not exclusively focused on biomass yield (kg/ha<sup>1</sup>) but on the yield of the productive complex, including essential oils and active components with biological and/or pharmaceutical action, there are no commercial products formulated for plant development and production for medicinal purposes.

It should be highlighted that medicinal plant production should not be based on structural or phenological similarity with leaf, fruit and/or root

vegetables or with landscaping plants. Medicinal plant production requires research and technology that can promote and establish massive production chains capable of supplying the internal market and strengthening current public policies, such as RENAME, RENISUS, PNPMF and APL.

These public policies are aimed at strengthening the medicinal plant production sector, thus guaranteeing the medicinal plant supply, i.e., the raw material destined for essential drug and dry plant production to be acquired by the users of the Unified Health System (SUS). Although these public policies are currently in force, medicinal plant production remains insufficient to meet the national demand for raw materials.

Basic advancements in medicinal plant production are therefore necessary, namely, regarding inputs (organic composts and vermicompost), plantation and management protocols, and other goods, services and technology. The organic products (organic composts and vermicompost) currently available in the market for agroecological cultivation (organic, biodynamic, ecological and biological), their composition and recommendations for their application to crops are presented in Table 1.

**Table 1.** List of commercial organic composts and vermicompost available in the Brazilian market.

Product	Composition	Agricultural recommendation
<b>(1)</b> TeraFértil	Sanitary waste and organic residues	Citrus trees, eucalypt, sugarcane, flowers, coffee, fruit trees, trees, flowers and lawns
SaneFértil	Sanitary waste and organic residues	Eucalypt, sugarcane, ornamental plants, coffee
<b>(2)</b> EcoAdubo Organic fertilizer	Not described	All types of plants: delicate flowers such as orchids, roses and violets; ornamental plants, such as ferns and palm trees, lawns
<b>(3)</b> MAGMAton	Not described	Seedlings, Leaf vegetables, fruit vegetables, tubers, coffee, cereals, citrus trees, bananas, fruit trees, gardens, flowers, lawns, pastures and grass fields
<b>(4)</b> McBiofert	Animal origin and free amino acids	All crops
Folhito MIX Organic Fertilizer	Commercial laying hen manure (pure manure), gypsum (sulfur rich), sewage sludge from cold-storage rooms and agroindustry (nitrogen rich), eggshell (calcium rich), ash from wood-burning boilers (phosphorus rich), unusable feed	Corn, tobacco, soybean, pastures (oat, ryegrass, Tifton grass, Aries, Brachiaria), wheat, barley, canola, rice, bananas, onions, native fields, walnut trees, olive trees, gardens, vegetables, fruit trees
Lithothamnium Alga	Marine algae Lithothamnium	Cotton, corn, rice and wheat, soybeans, beans and peanut, sugarcane, coffee and cocoa, garlic, onion, carrot and yam, potatoes, cassava, leaf and fruit vegetables, fruit trees, garden plants, ornamental plants, orchids

Aubos Ouro	Poultry manure	All crops
(5)		
Azet	Bagasse, grape stems and seeds, peat, ash from acacia wood, eucalypts and poultry manure and bed.	
Alga MC	Marine algae - <i>Ascophyllum nodosum</i>	Citrus trees and fruit trees, melons, watermelons, zucchini, cucumbers, potatoes, onions, artichokes, tomatoes, eggplants, peppers, strawberries, lettuce, spinach, celery, alfalfa, clover, vines
Algasol	Marine algae ( <i>Ascophyllum nodosum</i> ), natural extracts, betaine, oligosaccharides, humic extract	All crops
MC Armor	Amino acids and biomolecules	Woody plants, vegetables, citrus trees and ornamental plants
MC Biocomplex	Plant extracts and micronized mineral phosphorus, amino acids, humic substances and natural plant extracts, yeast protein and rock phosphate.	Horticulture
MC Biogo	AATC: 5.00%; Fulvic acid 0.10%	Vegetables, strawberries, potatoes: 50-100 ml / hl; olive trees, citrus trees, fruit trees, vines: 50 ml / hl.; winter cereals, rice, beets, cotton
Biole-C	Protein hydrolysate	Nurseries, ornamental plants, tropical plants, vine: 80-100 g / ha; fruit trees, olive trees, legumes, strawberries: 100-120 g / ha; cereals, corn, rice, industrial crops: 180-200 g / ha
Biole-R	Protein hydrolysate, fulvic acid: 4.80% (oligopeptides, extract of algae <i>Ascophyllum nodosum</i> )	Fruit trees, olive trees, strawberries: 4-5 l / ha; fruits and vegetables: 4-5 l / ha; flowers: 4-5 l / ha; seeds
MC Ecosoil S 10-0-5	Granular compost, Humic acids, fulvic acids 45%.	All crops
MC Ecosoil S Humic	Potassium enriched leonardite humic and fulvic acids	Tree species
MC Ecosoil S Petro 330 Ryzeaplus	Algae and RyZeaPlus (last generation mycorrhizae) and microorganisms	Olive trees: 800-1000; vines: 600-800; cereals: 500-700; durum wheat, wheat, lupine beans: 300-400; fruit trees: 800-1000; apricots, tangerines: 900-1100; vegetable crops: 800-1000; radishes, onions: 600-800; zucchini, carrots: 600-800; endives, spinach, potatoes: 700-900; tomatoes, 1000-1100; ornamental plants, lawn
MC Fulvic S 95	Fulvic acids: 95%	Not described
MC Humic S 80	Humic organic amendment composed of potassium humate from American leonardite, treated with potassium hydroxide	Alfalfa and forage: 3-10 kg / ha; rice, cereals and beans: 2-3 kg / ha; lawns and sport areas: 1-2.5 kg / ha; citrus trees, fruits, bananas and vines: 1-3 kg / ha; corn, potatoes and beets
MC Humic-Fulvic 20	Yeast and microorganisms	Vegetables, fruit, citrus trees: 7-12 l / ha; Olive trees: 12 l / ha; Banana: 50-60
MC Orgânico 855H11	Solo Total humic extract 14.37%; humic acids 5.62%; fulvic acids: 8.75%; ADENINE, ZEATIN, BETAINS and MANITOL	Vegetables, strawberries, citrus, vines, bananas
(6)		
Agrobio	Boric acid, wood ash, castor bean cake, meat and bone meal, copper sulphate, cobalt,	Seedlings, leaf and fruit vegetables, perennial crops

	manganese, magnesium, zinc and water, milk, molasses, magnesium thermal phosphate, iodine solution and manure	
Biogea	Fresh organic matter: fresh manure, remains of organic vegetables and fruits, coco-grass, natural phosphate and rock powder	Seedlings, fruit and leaf vegetables, perennial crops and fruit trees
Biofertilizer-	Whey, bone meal, ash, molasses and microorganisms	Vegetables, cereals and fruit trees
(7) Folhito Mix	Commercial laying hen and broiler manure – pure manure; gypsum – sulfur (S) rich; exhausted substrate from mushroom production; eggshells - calcium (Ca) and sulfur (S) rich; unusable feed	Corn, tobacco, soybeans, pastures, vegetables, gardens, rice, bananas, onions and fruit trees
Folhito Compostagem	Poultry bedding; animal manure; Industrial process sweep; sewage sludge; green residues (tree pruning and biomass residues and similar); residues from cafeterias or restaurants; dust from industrial processes (tobacco dust, sawdust and similar); ash from biomass combustion boilers; animal and plant remains in general	Not described
(8) Fishfertil- active	Fish hydrolysate (sea fish), sugarcane molasses, citric acid and saccharides	Commercial crops and ornamental plants
Fishfétil K	Fish hydrolysate (sea fish), sugarcane molasses, potassium sulfate, citric acid and saccharides	Commercial crops and ornamental plants
Fishfétil indure	Fish hydrolysate (sea fish), crustacean hydrolysate (crustacean shells), sugarcane molasses, edible citric acid and saccharides	Flowers, ornamental plants and lawns
Fishfétil classic	Fish hydrolysate (sea fish), sugarcane molasses, citric acid and saccharides	Commercial crops
(9) Biorganic	MZE Rock powder, cereal meal and sugarcane molasses	Not described

List of Companies accessed: (1) Terra Fétil –organic fertilizer; (2) Plantei – fertilizers - organic; (3). NutriSafrá; (4). MfRural; (5) Neudfor; (6) Agrobio; (7) Folhito Mix; (8) Fish fétil; (9) Microbio;

The agricultural and animal farming residue composition of the 33 products listed above is diverse. However, the use of coffee straw and vinasse is not directly mentioned, and most are enriched with some elicitor molecule (fulvic acid, humic acid, free amino acids and algae) in addition to microorganisms that efficiently contribute to promoting plant growth (CALVO; NELSON; KLOEPPER, 2014).

These commercial products are mainly destined for cereals, fruits and vegetables, annual crops and flower production. No recommendations for application to medicinal plants were found. Although many medicinal plants present similar development to some of the listed species, the focus is raw material and not the effect of the commercial product on the elicitation of active components with pharmacological and biological properties.

However, residue recycling is essential to reduce the consumption of natural resources in agriculture, since new products (organic composts and/or vermicompost) are produced from the residues of industrial and agricultural activities, which can be applied to the production of different crops. In addition to allowing for nutrient recycling, these organic composts and vermicompost act as soil conditioner, increasing the levels of organic matter and resulting in improved physical, chemical and biological soil characteristics (WU et al., 2014; MORAES, 2015; LIM; LEE; WU, 2016; SOARES et al., 2017).

However, composting is the most often used and accepted method of organic residue recycling in agriculture because it stabilizes the material, avoiding nutrient immobilization and phytotoxicity (GUIDONI et al., 2013). Organic compost has

several benefits for agricultural production and for the soil, since in addition to supplying nutrients to plants, it promotes the complexation of toxic elements and micronutrients, improves soil structure, and results in higher microbial activity, soil carbon accumulation, and water infiltration and retention, acting as a soil conditioner (SANTOS et al., 2014).

The reuse of solid residues to produce organic composts and/or vermicompost is therefore a technology with potential for plant growth promotion, since the byproducts of agroindustry (agriculture and animal farming) constitute a health problem (DIAS et al., 2012), contaminating soil, water, air and people when they are not disposed of in a manner that is coherent and responsible toward the environment. In addition, conventional fertilizers that depend on natural resources (mineral fertilizers) are becoming exhausted by the irresponsible exploitation of large agribusiness companies and multinationals.

The need for advances in the production of technologies applied to medicinal plant development and growth that not only promote raw material production but also elicit the secondary metabolism, resulting in higher essential oil yield and active ingredient concentrations, should be highlighted.

## FINAL CONSIDERATIONS

Agricultural production chains are of great importance to the economic movement of small and large producers. However, methods of reusing agricultural and animal farming residues need to be established to avoid contamination of water sources, soil, fauna, flora and population. In addition, countering the agrobusiness production model,

organic food production is undergoing constant growth, along with medicinal plant production, with a high demand for technologies, services and products. This sector will only be able to advance through the efforts of research institutions and continuing education, strengthening family farming and the permanence of families in the countryside. The production of specific organic composts and vermicompost for the production of medicinal plants (raw material) rich in active compounds with biological and pharmacological activity is therefore crucial to strengthening the national pharmaceutical industry for both the production of herbal drugs and the consolidation of public policies related to medicinal plants and herbal drugs through the prescription of dry plants by the SUS. It is highlighted that developing technologies and studies for the reuse of residues from sugarcane, beef and dairy cattle and coffee production for the production of commercial products and/or social technology, which can then be reapplied to the production sector, will fulfill the social duty of knowledge of the population and environment, generating jobs, products, sovereignty and food safety through the production of organic food and medicinal plants.

## ACKNOWLEDGMENT

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001, Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) and Fundação de Amparo à Pesquisa de Minas Gerais (FAPEMIG) for the financial support for carrying out the work.

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**RESUMO:** Embora a demanda por fertilizantes orgânicos na agricultura seja crescente, ela ainda é incipiente em alguns setores produtivos, como a produção de plantas medicinais, que não possui tecnologia específica para seu desenvolvimento. Os resíduos sólidos são altamente contaminantes para fontes de água, solo, populações e biodiversidade, mas podem ser potencialmente utilizados para a produção de compostos orgânicos e vermicomposto, tal produção não só possibilita a reciclagem de nutrientes, mas também atua no condicionamento do solo, aumentando a matéria orgânica do solo e melhorando seu aspecto físico, químico e características biológicas, além do fortalecimento da produção orgânica com ênfase na produção de plantas medicinais. Nesse contexto, foram revisadas as recomendações e aplicações dos fertilizantes orgânicos disponíveis no mercado; além disso, a iminente demanda socioeconômica pela produção de composto orgânico e vermicomposto foi contextualizada a partir dos resíduos da produção de café, cana-de-açúcar e pecuária para aplicação na cadeia produtiva de plantas medicinais. Conclui-se que embora esses setores produzam uma quantidade considerável de resíduos, eles não estão sendo reaproveitados na formulação de compostos orgânicos e vermicomposto, e não foram encontrados fertilizantes orgânicos comerciais recomendados para a produção de plantas medicinais. Sendo assim, a formulação de vermicompostagem e compostagem a partir do



reaproveitamento de resíduos agropecuários, são potenciais tecnologias sociais, econômicas e ferramentas a serem valorizadas e disseminadas para os agricultores tradicionais e familiares.

**PALAVRAS-CHAVE:** Agroecologia. Horticultura. Metabolismo secundário. Resíduos sólidos. Sustentabilidade.

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