

The potential of family farming to achieve the Sustainable Development Goals in a mining region

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Abstract: This article addresses the potential of family farming to reach the Sustainable Development Goals. Based on data from the Agricultural Census for the municipality of Mariana, in the Iron Quadrangle (Quadrilátero Ferrífero) region of Minas Gerais, an analytical and evaluation model for the fulfillment of sustainability goals was created using indicators referring to the characteristics of production and family farmers. Our study is based on the conception of donut economy and sustainability, aiming to contribute to the debate on the need to overcome the extractive and predatory development model represented by mining. The results indicate the potential of agroecologically-based family farming for the fulfillment of sustainability goals, as well as pointing out challenges to be overcome, through public policies and social organization to promote a new development model in mining regions.

Keywords: Circular Economy; Family Farming; Quadrilátero Ferrífero; Sustainable Development; Sustainability Indicators.

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Introduction

A number of developing countries are struggling to meet the global environmental, social, and economic agendas (UNEP, 2010). In some Latin American and African countries, this difficulty is partly due to dependence on predatory extractive activities, such as mining, which limit the use of space for more sustainable and necessary activities, such as food production. In these places, we see a clear contradiction arising from the coexistence of different activities, such as mining and agriculture, both historically rooted in the socio-economic development of specific territories. More than a contradiction, it is often a dispute over territory and natural resources, and in regions with mineral wealth, mining tends to occupy a dominant position over other economic activities (MACONACHIE; BINNS, 2007; HILSON, 2016; URRIAGO-OSPINA et al., 2021).

The case of Brazil is a reference, both because it is one of the main food producers and because it is one of the largest producers and the largest exporter of minerals in the world. One of Brazil's main mining regions is the Iron Quadrangle (Quadrilátero Ferrífero - QF) in the state of Minas Gerais, which is home to more than 60% of Brazil's iron and aluminum deposits, as well as other minerals and gems (FERNANDES et al., 2016). Mining activities in the QF date back to the colonial period. Some 300 years later, the extraction of iron ore became more important, helping Brazil to become one of the world's two largest producers of this commodity. The history of mining has shaped the false idea that these areas are unsuitable for other activities, resulting in low diversification of land use (MESSIAS et al., 2023). This has resulted in ecosystem, social and economic problems, aggravated by the recent environmental disasters caused by the collapse of mining tailings dams (FERNANDES et al., 2016; CIONEK et al., 2019; TSCHAEN; MELLO; ROSA, 2021).

However, records point to the cultural tradition of land management for agricultural activities using agro-ecological practices that also date back to the colonial period, ensuring the supply of the local market for the large population established during the gold cycle (LAMIM-GUEDES, 2010; MESSIAS et al., 2015). Over the following centuries, agricultural production occupied a marginalized position, partially supplying the local market with subsistence crops. Although the extensive production model has not been established in this region, due to the peculiarities of the rugged terrain and dystrophic, metalliferous soil, agroecological agriculture, with the family production model, is part of the cultural framework of the local communities (MESSIAS et al., 2023). However, due to the lack of public policies and the use of labor primarily in mining, there is a dependence on the supply of products from other regions, since local production is insufficient for local demands (SILVA, 2002; CARRARA, 2007; DIAS; DIAS, 2019).

Another important aspect of the contradiction and conflict between mining and agriculture in the region is the threat posed by mining activities to the food security and sovereignty of the local population. The scale of production, the methods and rhythms of mineral extraction, the transformation of landscapes, and the exhaustion of land and water compromise local food production, revealing the unsustainability of capital territorialized by large mineral exploitation projects (CARVALHO, 2017; DELMOTTE, 2022).

Agriculture, in turn, plays an important role in the social and economic reproduction of the rural population (GRISA; GAZOLLA; SCHNEIDER, 2010).

Despite the obvious and measurable social and environmental impacts of mining activity, its importance is usually assessed through its economic results and supposed positive impacts on the development of the regions where it is practiced. In several municipalities of the Iron Quadrangle, Gross Domestic Product (GDP) figures indicate the extreme concentration of the productive structure in mining and support arguments in defense of the permanence of this activity, as it is practiced, at the risk of a lack of viable economic alternatives. In the municipalities of the QF, mining accounts for more than 50% of GDP, demonstrating the lack of productive diversification concentrated in activities with enormous social and environmental risks (CASTRO, 2021). In Mariana, the town where one of the world's biggest environmental disasters took place, mining accounted for almost 80% of GDP before the Fundão tailings dam burst in 2015. In 2020, these figures decreased to around 55%. The situation is similar in the municipality of Brumadinho, where another tailings dam burst in 2019. In 2020, mining contributed around 50% of GDP in the area. In these QF municipalities, agriculture contributes only around 1% of GDP (IBGE, 2022).

Faced with a global scenario of climate change and growing socio-economic inequalities, as well as a local context marked by socio-environmental disasters of enormous proportions caused by mining, it is imperative to seek new interpretative models that include social and environmental dimensions when assessing the potential of certain economic activities or sectors for development (FRUGOLI, 2015; RAWORTH, 2019). In order to advance in the defense of economic diversification, based on fairer and more sustainable production models, it is necessary to establish new metrics for evaluating social, economic, and environmental performance to demonstrate that activities such as agriculture are viable and promote the quality of human life in the territories (RAWORTH, 2019).

From this perspective, several studies have sought to develop measurement and assessment tools, such as indices and indicators, of the sustainability conditions of certain regions, sectors or activities, usually through case studies (ARAÚJO et al., 2022; FERREIRA; CORRÊA; COSTA, 2020; FRUGOLI, 2015; GUIMARÃES; FEICHAS, 2009; LOPATYNSKYI et al., 2023; VAITSMAN, 2023; VIGANÓ et al., 2023).

Walking hand in hand with these studies and considering the specificities of the context analyzed, we sought to assess the potential of agroecological family farming to promote sustainable development in the municipality of Mariana, which is regarded as a national historic heritage and located in the Iron Quadrangle in the state of Minas Gerais (IPHAN, 2014). The municipality of Mariana is strategic for this analysis, as it has an extreme economic dependence on mining activity and has become a worldwide emblematic reference point with regard to the socio-environmental impacts of mining (FERNANDES et al., 2016).

In this municipality, in recent years, there has been a significant increase in the number of rural establishments, from 207 to 392, accounting for an increase of more

than 50%, contrary to the downward trend in the number of establishments in the state of Minas Gerais and in Brazil in the same period (FORTINI, 2021; IBGE, 2006; IBGE, 2019). Although this increase may be related to the socio-economic effects of the Fundão dam collapse, more research is needed to establish causal relationships. Some studies have pointed out the socio-economic effects of dependence on mining, suggesting that family farming is one of the activities with the greatest potential to contribute to productive, labor, economic, and social restructuring in this municipality and the region, even allowing mining workers to return to the family farms they had “left behind” (SINGULANO; VIANA; INÁCIO, 2023; SILVA; SILVA; TUPY, 2019).

In order to understand the potential of agroecological family production for sustainable development, we do not use interpretative models directly linked to the economy based on the extractivist model and orthodox metrics such as GDP. Moreover, we sought an analytical model based on indicators of compliance with sustainability targets. It is noteworthy that our study is not intended to compare the level of sustainability between the mining and agricultural sectors, but to shed light on a sector that is marginalized in terms of public investment and little studied in the region, which is generally known for mining.

Our analysis takes, as its theoretical reference, the concept of the circular economy, or donut economy, in which development is no longer measured only by Gross Domestic Product (GDP) and incorporates metrics of the pressure and finiteness of natural resources and the social foundation associated with human well-being (RAWORTH, 2019). One of the analytical advantages of this model, proposed by economist Kate Raworth, is that it makes it possible to work with indicators directly related to various aspects of the ecological ceiling and the social foundation. Raworth (2019) proposes twelve social foundation indicators that point to goals to be pursued for a circular economy that actually meets human needs with equity and justice, namely: food, health, education, income and work, water and sanitation, energy, networks, housing, gender equality, social equality, political voice, peace, and justice. The economist's propositions, based on her experiences in sustainable development organizations and projects, clearly bring the donut economy model closer to the United Nations' Sustainable Development Goals (SDGs). Raworth (2019) even recognizes that the twelve dimensions of the social foundation are derived directly from the SDGs.

Thus, in our study, the sustainable development goals represented by the SDGs provide the parameters for interpreting the local indicators. These indicators were constructed from data on family farming in the municipality of Mariana and aim to assess the degree of approximation to global and national sustainability targets and demonstrate the potential of agroecological family production for building a new regional development model. We also identified bottlenecks or challenges to meeting the targets that require action on the part of the state and civil society to overcome.

Methods

The socioeconomic data for family farming in the municipality of Mariana was extracted from the 2017 Agricultural Census using the Sidra platform, organized in spreadsheets, and worked on using statistical software (IBGE, 2019). The following variables from the 2017 Agricultural Census were selected: 1) Number of family farming establishments and total; 2) Gender of the head of the farming establishment; 3) Age of the head of the farming establishment; 4) Schooling of the head of the farming establishment; 5) Income related to farming production; 6) Types of production used by farmers (vegetable or animal); 7) Use of organic production; 8) Use of pesticides; 9) Destination of agricultural production according to the status of the head of the establishment; 10) Destination of agricultural production according to the person responsible for production in the agricultural establishment; 11) Management methods and techniques used; 12) Use of land; and 13) Income from production.

The variables were selected considering aspects of family farming and agroecology related to the SDGs, according to the guidelines of the Food and Agriculture Organization of the United Nations (FAO) and those described in the literature (ONU, 2015; FARRELY, 2016; PEIXOTO, 2022). Considering the twelve social indicators proposed by Raworth (2019) linked to the SDGs, agroecology is directly or indirectly related to all of them. However, we have worked with nine indicators, given the availability of information in the census, which demonstrate the direct relationship of the characteristics of family farming to certain SDGs and we have commented on how this activity may indirectly contribute to the fulfillment of the other goals based on its attributes.

Some indicators were based on just one variable, while others were based on two variables. In order to make it easier to represent the indicators, we created codes consisting of one letter and two numbers, with the letter I differentiating the local indicators from the numbering of the national targets, the first number indicating the SDG to which it refers and the second number differentiating one indicator from the others (Chart 1).

Chart 1 - Variables containing aspects of family farming in the municipality of Mariana related to the indicators developed.

Variables	Indicators
8	I.2.1
9; 10	I.2.2
1	I.2.3
7	I.2.4
6; 11	I.2.5
5	I.2.6
4	I.4.1
2	I.5.1

3	I.8.1
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Source: The author, 2023.

We have systematized the results by presenting the values of the local indicators and their correspondence with specific national targets and indicators (Table 2).

The potential of agro-ecological family farming to fulfill the SDGs in the municipality of Mariana

In order to understand the contribution of family farming to the fulfillment of the SDG targets, we developed nine indicators based on variables from the 2017 Agricultural Census for the municipality of Mariana. These local indicators are related to national targets and indicators drawn up by the Institute for Applied Economic Research (IPEA), which is responsible for adapting the global targets to the Brazilian context (IPEA, 2018). In some cases, the local and national indicators are not identical, but we seek a correspondence, based on the orientation of the necessary adaptation of the goals and indicators to the subnational realities (IPEA, 2018). To this end, we looked at the data that was available reliably and periodically on family farming in the place of study, without losing sight of the possibility of comparing it with national data (Chart 2). However, we do not evaluate performance in meeting targets, as we are working with data for a specific period. However, future reassessment is likely to be carried out on the basis of current data.

Chart 2- Indicators of compliance with the Sustainable Development Goals (SDGs) by family farming in the municipality of Mariana

SDGs	National indicators	Code	Local indicators	%
2 - Zero hunger and sustainable agriculture	2.4.1 - Proportion of agricultural area under productive and sustainable agriculture	I.2.1	% of family farmers who do not use pesticides.	97.44
		I.2.3	% of rural Family Farming establishments.	69.50
		I.2.4	% of family farmers who use organic farming.	18.50
		I.2.5	% of family farmers who use management techniques capable of reconciling agricultural production with the conservation of natural resources.	46.7
	2.1.2 - Prevalence of moderate or severe food insecurity.	I.2.2	% of family farmers who use their production for self-sufficiency.	39.8
	2.3.2 - Average income of small food producers (by category).	I.2.6	% of family farmers who earn more from agricultural activities than from off-establishment activities.	29.08
4 - High quality education	4.5.1 - Rural/urban (educational) parity ratios (among other categories)	I.4.1	% of family farmers who run agricultural establishments and have at least primary education.	44
5 - Gender equality	5.a.1 - (b) proportion of women among owners and holders of agricultural land rights, by type of ownership.	I.5.1	% of female family farmers who run agricultural establishments.	20.66
8 - Decent work and economic growth	8.6.1 - Percentage of young people (aged 15-24) who are not in the labor force (employed and unemployed), are not students and are not in job training.	I.8.1	% of family farmers who run agricultural establishments and are under 25 years old.	1.53

Source: The author, 2023.

National indicator 2.4.1 refers to the proportion of the area under sustainable agriculture, in line with the goals of overcoming hunger, promoting food security, improving nutritional conditions and promoting sustainable agriculture. In drawing up the corresponding local indicators, we considered: the percentage of establishments that fall into the family farming category (I.2.3) and characteristics of family production in line with sustainable agriculture (I.2.1, I.2.4 and I.2.5).

We observed that the majority of rural properties in the region fall into the family farming category. This category incorporates information on the size of the property, the labor force and management, as well as the fact that family farming has a production model that reconciles self-sufficiency and the destination of markets, which is in line with national target 2.3, relating to increasing the productivity and income of small producers with a view to their social reproduction and economic development (BRASIL, 2006; GRISA; GAZOLLA; SCHNEIDER, 2010; TOADER; RAMAN, 2015; PAL et al., 2017; NEPOMOCENO; CARNIATTO, 2023). We believe that indicator I.2.3 provides an approximation of national indicator 2.4.1, as it shows the prevalence of small farms with specific family production characteristics.

With regard to the area and productivity of these family units, although they are relevant and incorporated into national indicator 2.4.1, one must not lose sight of the fact that the sustainability characteristics of production are fundamental criteria for assessing whether the targets have been met. We have therefore opted for indicators that allow us to assess the sustainability of local production and the other information is considered complementary. The area of family production in the municipality of Mariana totals almost 9,000 ha, with an average of 22 ha per establishment, more than 65% of which have between 10 and 50 ha. In terms of agricultural production, considering permanent and temporary crops, the municipality produced 3,465 tons in 2017 (IBGE, 2017; IBGE, 2019).

Indicators I.2.1, I.2.4 and I.2.5 relate directly to national indicator 2.4.1. It can be said that the sustainability of local agriculture is an aspect that deserves to be highlighted. As evidenced by the local indicators, family production in the municipality generally does not use pesticides (I.2.1), a portion of producers use organic farming (I.2.4) and use techniques that allow for the conservation of natural resources (I.2.5), such as level planting, crop rotation, soil rest, slope conservation, riparian forest recovery, reforestation, spring protection, gully stabilization and forest management. It can be considered that the local production system is based on biodiverse agroecosystems that make rational use of energy and maximize the use of locally available inputs, capable of restoring and increasing the resilience of degraded ecosystems, including by mineral extraction activities (JÚNIOR et al., 2014; RODRÍGUEZ, 2016; URRIGO-OSPINA et al. 2021; PEIXOTO; BREIER; SOARES, 2022; ATAEI et al., 2023).

With regard to national indicator 2.1.2, we did not directly assess the condition of food and nutritional insecurity (FNI), but the percentage of production destined for self-consumption through indicator I.2.2, whose information was available in our data source. The literature establishes a relationship between the use of production for self-consumption and better conditions of food and nutritional security (FNS) among family

farmers (GRISA; GAZOLLA; SCHNEIDER, 2010; ONU, 2015; ROOP et al., 2022; TAPSOBA; BRUN, 2024). In a study on the food security conditions of family farmers in Mariana, it was revealed that 28.5% are in a situation of FNI, higher than the figures for the state of Minas Gerais and which may be related to the low percentage destined for self-consumption (39.8%) according to our indicators (TEODORO et al., 2023). Thus, the indicator we are working with provides an approximation of the national indicator and can be complemented with data related to the FNS status of family farmers.

When it comes to producers' income, this information is important for establishing a relationship with national indicator 2.3.2. However, in drawing up indicator I.2.6, we prioritized information on the share of farmers' income that comes from farming over that which comes from outside the rural establishment. This is primarily due to the characteristics of local family farming, where concomitant employment in other activities is common, including mining (SINGULANO; VIANA; MESSIAS, 2023). In addition, in order for family farming to show its potential to contribute to a sustainable production model and to the fight against hunger, it is necessary to increase income from rural activity, one of the goals related to SDG2. Information on producers' income can be considered as complementary information for the interpretation of indicator I.2.6. Family and non-family farming establishments in the municipality had an average income of just over BRL 1,970.00 in 2017 (IBGE, 2019). It can be seen that, even considering the total number of establishments, the average income obtained per establishment can be considered low, being close to two minimum wages in the period considered. Furthermore, among family farmers, it can be seen that they often earn more from activities outside farming (I.2.6).

Some characteristics of rural establishments and producers show that there are challenges to be overcome to achieve the SDGs. Regarding family farmers, it can be said that aspects related to low schooling, gender inequality and the lack of job opportunities for young people stand out as the main bottlenecks to achieving sustainable development goals.

There is a low level of education among those responsible for managing agricultural establishments (I.4.1), with the majority of farmers not having completed elementary school, 15% of whom have never been to school. National indicator 4.5.1 refers to parity in access, permanence, and educational success, with an emphasis on the most vulnerable populations, such as the rural population. The proposed indicator reveals the persistent difficulty of access to education for family farmers.

With regard to gender inequality, national indicator 5.a.1 considers the proportion of women with secure rights to agricultural property. Our indicator I.5.1 shows that the smallest proportion of family farming establishments are headed by women. Nevertheless, female participation is significant and central to the agricultural production organization of family units, and is often underestimated (BALAINE, 2019; ASADULLAH; KAMBHAMPATI, 2021; LADIO, 2021; SENE; GNING, 2024). The invisibility of women's work in agriculture is linked to the social and cultural characteristics of patriarchal societies, which give men the task of supporting the family and the power of family leadership (SILIPRANDI, 2015; LADIO, 2021). Thus, it can be interpreted that women are present

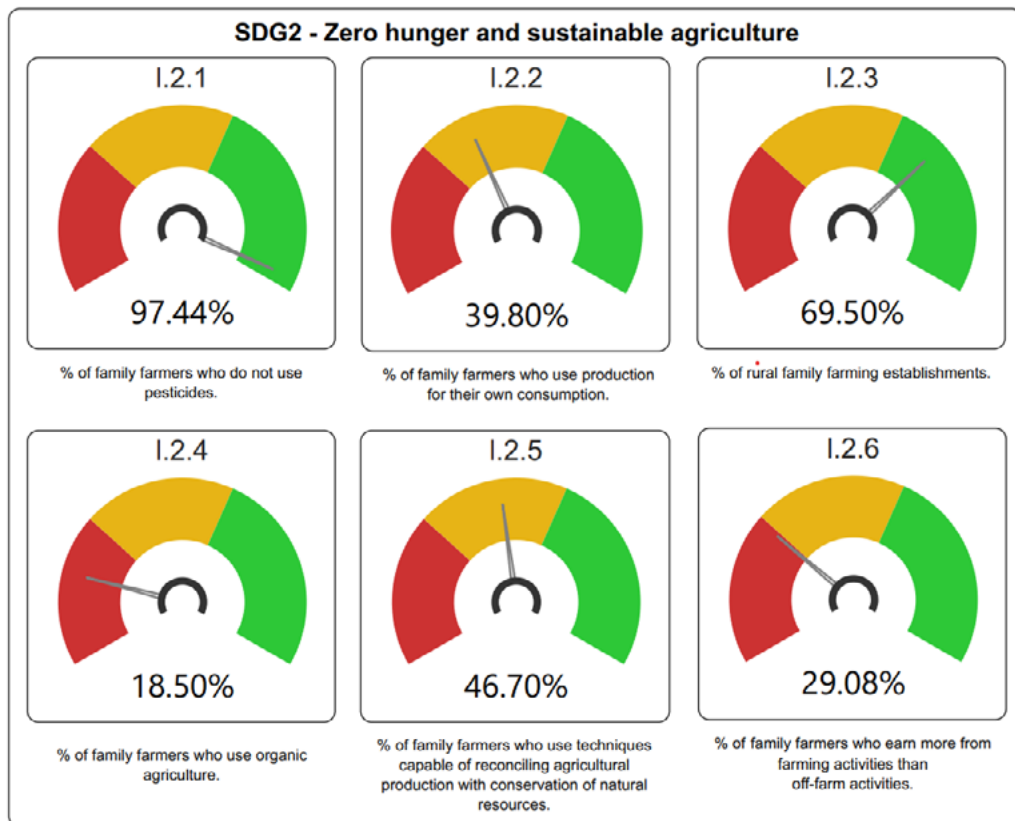
in rural establishments in the social context analyzed, carrying out various activities, but they are not declared to be the key players.

There is also a low rate of young people in management positions in agricultural establishments (I.8.1), which may be related to the family structure of management, work, and succession in establishments, in which young people may be employed, but not in the management of production units. This indicator may also highlight the ageing of the rural population and the shortage of young people in agricultural jobs and management. Target 8.5 indicates the need to achieve employment and decent work in an inclusive way and national indicator 8.6.1 refers to young people who are not in the workforce, studying or in training. We opted for an indicator that shows the participation of young people in the management of establishments, due to the specificities of rural work and the data available. Our results reveal the absence of young people in this sector and the need to include this segment in production and management activities, a reality common to other rural regions (SOSA et al., 2013; FOGUESATTO, 2020; DELAZERI et al., 2022).

Based on the interpretation of these results, we built infographics (Figures 1 and 2) as tools to demonstrate the level of approximation or distancing of goals that can be applied to different contexts. In the infographics, we positioned the indicators in three strata, represented by colors, namely: red: indicates 0% to 30% of meeting the target; yellow: indicates above 30% up to 60% of meeting the target; green: Indicates above 60% of meeting the target. Thus, for example, national target 2.4 aims to guarantee sustainable production systems by 2030, which can be assessed through indicators of the proportion of agricultural area under productive and sustainable agriculture. Our indicators refer to aspects that have a positive correlation with sustainable agriculture, so the closer the value of a local indicator is to 100%, the closer it is to meeting the target. We take as a *proxy* that a 100% rate indicates that the target has been met.

In the first infographic (Figure 1) we try to demonstrate how family production contributes to achieving the goals related to SDG2 - Zero Hunger and Sustainable Agriculture.

Figure 1 Achievement of targets related to SDG2 - Zero hunger and sustainable agriculture



Source: The author, 2023.

Firstly, indicator I.2.4, which refers to organic production, is in the bottom stratum. Although this is an important aspect of meeting the target for sustainable agriculture, it is below 30%, and it is possible to increase the percentage of family farmers who use organic farming. On the other hand, the current rate of just over 18% is probably due to difficulties in organizing farmers and certifying organic production, as indicators I.2.1 and I.2.5 show the potential for sustainability in local agriculture.

Indicator I.2.1 shows that almost all farmers do not use pesticides (97.44%). This indicator refers to a key element in ensuring sustainable food production systems and implementing resilient agricultural practices that increase productivity and production, help maintain ecosystems, strengthen the capacity to adapt to climate change and progressively improve the quality of land, water and soil (DOGLIOTTI et al., 2014; ONU, 2015).

In relation to indicator I.2.5, it can be seen that almost half of family farmers use production methods related to traditional ecological knowledge and which allow for the conservation of natural resources (OLIVEIRA JUNIOR et al., 2014; URRIAGO-OSPINA

et al. 2021; MESSIAS et al., 2023).

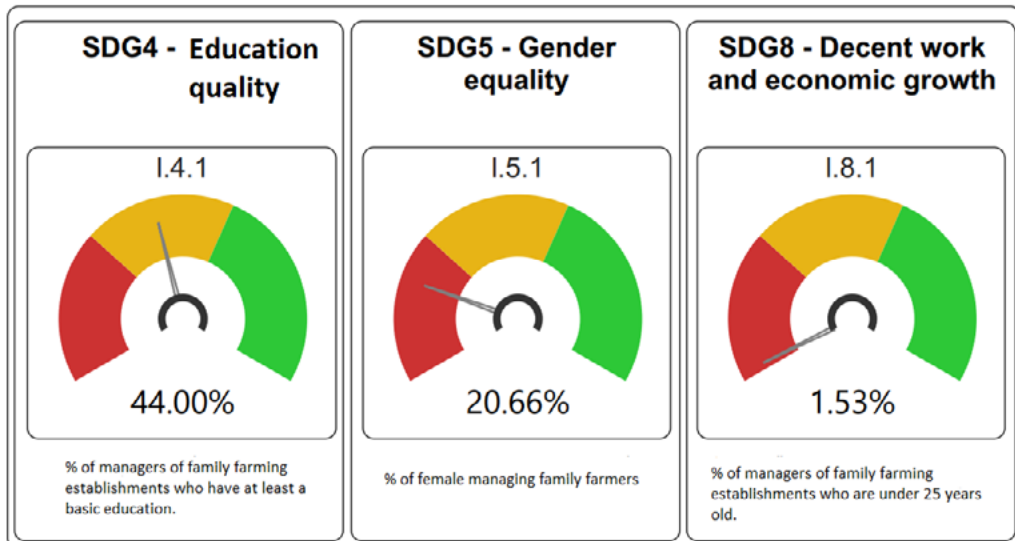
In turn, indicator I.2.6 shows that only 29.08% of farmers earn more from agricultural activities than from other sources of income. It is therefore necessary to increase the yields and productivity of the activities carried out in agricultural establishments in order to reach SDG2-related goals (ONU, 2015).

In agricultural establishments, production is destined for both marketing and self-supply (I.2.2), with the share destined for self-consumption accounting for 39.8%. Increasing productivity, guaranteeing a portion that can be used for self-consumption, is one of the possible strategies for improving food security for this population (GRISA et al., 2010).

The predominance of farms in the family farming category (I.2.3) (69.50%) also represents potential for meeting the target, since secure and equal access to land is one of the conditions for small-scale food producers to be able to increase agricultural productivity and financial income from agricultural production (ONU, 2015). Furthermore, agroecological and sustainable practices are associated with the model of family farming enterprises on small local properties (MESSIAS et al., 2023).

We chose to build an infographic for SDG2 because it is the most significant for assessing the potential of family farming in the region studied and, therefore, where the greatest number of indicators are concentrated. For the other SDGs, we chose to present them together in a single infographic (Figure 2).

Figure 2 Achievement of targets related to SDG4 - Quality education, SDG5 - Gender equality and SDG8 - Decent work and economic growth



Source: The author, 2023.

The concentration of indicators related to education, gender equality and decent work in the lower strata reveals that these areas are the major bottlenecks for family farming in the region studied to get closer to sustainable development goals.

There is a prevalence of family farmers with low levels of schooling (I.4.1), with only 44% having completed at least elementary school. In this sense, it is necessary to raise the level of schooling to achieve the goal of access to inclusive, quality, and equitable education, and to promote learning opportunities capable of ensuring that everyone acquires the knowledge and skills necessary to promote sustainable development (ONU, 2015).

Indicator I.5.1 suggests that only around 20% of those responsible for the management of agricultural establishments are female, making it a challenge to increase female visibility and participation in the management of establishments in order to achieve gender equality and foster the empowerment of women in rural areas (ONU, 2015).

Finally, with regard to indicator I.8.1, there is a low number of young people in charge of production units, since only 1.53% of those responsible for managing agricultural establishments are under 25 and more than 60% are over 55. Improving the levels of this indicator should not only enable young people to access employment and income, but also contribute to promoting safe and secure working environments (ONU, 2015).

Conclusions

In the context described about the QF, two economic activities stand out which are guided by diametrically opposed conceptions of sustainable development - mining and family farming. These activities coexist in the territory in a complex dynamic relationship that involves conflicts, contradictions, historical alternations in land use and codependence, but with a clear predominance of mining activity guided by the logic of profit and predatory economic growth.

Against this backdrop, we seek to demonstrate that sustainable activities that promote the quality of human life in the territories are possible and economically viable, such as family food production. This activity, in addition to enabling the rehabilitation of degraded areas and the diversification of land use through the use of agricultural activities, presents sustainable technologies that contribute to environmental conservation, preserving environmental services and subsidizing the socio-economic well-being of families living in the countryside. In other words, it is an activity with the potential to contribute to a circular economy that allows social and material deprivation to be overcome, without leading to environmental degradation (RAWORTH, 2019).

The results strongly indicate the potential of agroecological family farming to meet sustainability goals and promote a new development model in this mining region, although some challenges need to be overcome. Directly, we point to the already existing potential related to the development of sustainable agriculture and the fight against hunger (SDG 2). The challenges encountered indicate the need for actions to promote quality education (SDG 4), gender equality (SDG 5) and the generation of decent work and economic growth (SDG 8). Indirectly, we can point out that agroecological family

farming in the region can contribute to achieving sustainability goals because it enables the use of techniques that make efficient use of water resources in agricultural production (SDGs 6 and 14), enables the development of actions that provide for combating climate change and its impacts (SDG 13), contributes to the maintenance of terrestrial life (SDG 14), fosters industrial development, innovation and infrastructure in rural areas (SDG 9), contributes to the reduction of inequalities (SDG 10), to the development of sustainable cities and communities (SDG 11), boosts sustainable consumption and production (SDG 12) and guarantees the health and well-being of consumers of the food produced, as well as those engaged in agricultural work (SDGs 3 and 8) (FARRELLY, 2016; GORIS et al., 2021; THAKUR et al., 2022).

In this way, it can be said that agroecological family farming has great potential to help overcome the predatory growth model and move towards a development model based on the concept of a circular economy. We have shown that the characteristics of family production in the region studied are directly or indirectly aligned with the twelve social foundation indicators proposed by Raworth (2019). Thus, local indicators I.2.1, I.2.2, I.2.3, I.2.4, I.2.5 and I.2.6 relate directly to indicators relating to food, as well as indirectly to those relating to health, water and sanitation, energy, networks, and housing. In turn, indicators I.4.1, I.5.1 and I.8.1 relate to those proposed by the author regarding education, gender equality, income, and work, and also those regarding social equality, political voice, peace, and justice (RAWORTH, 2019). Thus, we can conclude that, to the extent that family farming meets these sustainability objectives and goals, it contributes to building the path towards a model of a distributive and regenerative economy by design (RAWORTH, 2019).

Although Raworth's (2019) theoretical model was designed for national contexts, problematizing limitless growth or the difficulty of maintaining GDP growth rates in national economies in the 21st century, in our work we seek to demonstrate how this framework can be used to analyze local or regional contexts, as well as specific sectors. In this sense, we sought to reflect on the need for economies, on different scales, which allow a balance between human needs and natural resources. As family farming meets globally agreed sustainability goals and targets, it can contribute to building the path towards a circular economy model. However, for this to be possible, it is necessary to improve the levels of some indicators. The main aspects that may stand as challenges for meeting the sustainability targets relate to issues of gender, schooling, work, and income from farming. This scenario calls for public policies aimed at empowering women, social equality in rural areas, education and job and income generation, especially for young people.

Despite the limitations arising from the data source used (SANTANA; SANTOS, 2020; FORTINI, 2021), our study might offer a significant contribution by revealing the potential of agroecological family production in the Iron Quadrangle, an activity that is still little studied in the region. We hope that our analytical model can serve as a reference for further research, including future re-evaluations of the same context and comparisons between regions with similar characteristics. Last but not least, the representation of the results in a schematic and didactic way, by means of infographics, allows communication

to wide audiences and is suitable for executive summaries and policy reports. Having said that, we hope to provide input for the public debate and for the design of new local development policies.

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Potencial da agricultura familiar para alcançar os Objetivos do Desenvolvimento Sustentável em uma região mineradora

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Resumo: Este artigo trata do potencial da agricultura familiar para o cumprimento dos Objetivos do Desenvolvimento Sustentável. A partir de dados do Censo Agropecuário para o município de Mariana, na região do Quadrilátero Ferrífero de Minas Gerais, foi elaborado um modelo analítico e de avaliação do cumprimento de metas de sustentabilidade por meio de indicadores referentes a características da produção e dos agricultores familiares. O estudo se fundamenta na concepção de economia circular e de sustentabilidade visando contribuir para o debate sobre a necessidade de superação do modelo de desenvolvimento extrativista e predatório representado pela mineração. Os resultados indicam o potencial da agricultura familiar de base agroecológica para o cumprimento de metas de sustentabilidade, bem como apontam desafios a serem superados, por meio de políticas públicas e organização social, para a promoção de um novo modelo de desenvolvimento em regiões mineradoras.

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Palavras-chave: Agricultura Familiar; Desenvolvimento Sustentável; Economia Circular; Indicadores de Sustentabilidade; Quadrilátero Ferrífero.

Potencial de la agricultura familiar para alcanzar los Objetivos de Desarrollo Sostenible en una región minera

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Resumen: Este artículo aborda el potencial de la agricultura familiar para cumplir los Objetivos de Desarrollo Sostenible. A partir de los datos del Censo Agropecuario del municipio de Mariana, en la región del Quadrilátero Ferrífero de Minas Gerais, se elaboró un modelo de análisis y evaluación para el cumplimiento de las metas de sostenibilidad a partir de indicadores referidos a las características de la producción y de los agricultores familiares. Nuestro estudio parte de la concepción de economía circular y sostenibilidad, con el objetivo de contribuir al debate sobre la necesidad de superar el modelo de desarrollo extractivo y depredador que representa la minería. Los resultados indican el potencial de la agricultura familiar de base agroecológica para el cumplimiento de las metas de sostenibilidad, así como señalan desafíos a ser superados, a través de políticas públicas y organización social, para la promoción de un nuevo modelo de desarrollo en regiones mineras.

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