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Resilience of small rice farmers in Colombia and its implications for Food Sovereignty in the context of the pandemic

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Abstract
The present work is the result of the collaboration between two master's and doctoral thesis students committed to the Latin American rural world and interested in carrying out an analysis of the capability for resiliency of small rice producers in Colombia and its implications for Food Sovereignty against a scenario of vulnerability marked by the effects of Climate Change (CC) and the Free Trade Agreement (FTA) in the current pandemic and post-pandemic situation. Returning to the results of the master's thesis obtained through the MESMIS methodology, based on the characterization and classification of 50 rice producers in the Department of Huila, and based on the Sustainable Livelihoods Approach (EMVS) and Marcos of Community Capital (MCC), we established resilience points for three types of producers, and, based on some of the cultural indicators of food sovereignty obtained through Participatory Action Research (PAR) for a doctoral theses, we analyzed the characteristics of the three links of the rice production process, with the data shared by the 50 participants on the daily reality of their main economic activity, to identify dependency and decision-making factors as keys to consider for the construction of the sustainability of the system they belong, from to the daily realities they live and face.
Keywords: Sustainability. Arifood systems. Sustainable development. Agroecology.

Capacidade de resiliência de pequenos produtores de arroz na Colômbia e suas implicações para a Soberanía Alimentaria no contexto pandémico

Resumo
O presente trabalho é resultado da colaboração entre dois alunos de mestrado e doutorado comprometidos com o campo latino-americano, interessados em realizar uma análise da capacidade de resiliência de pequenos produtores de arroz na Colômbia e suas implicações para a soberania num cenário de vulnerabilidade, marcado pelos efeitos das mudanças climáticas e do Acordo de Livre Comércio na atual situação de pandemia e pós-pandemia. Voltando aos resultados da dissertação de mestrado obtida através da metodologia MESMIS, com base na caracterização e classificação de 50 produtores de arroz no Departamento de Huila e no estabelecimento com base na Abordagem de Meios de Vida Sustentáveis (EMVS) e Quadros de Capital Comunitário (MCC), os pontos de resiliência são estabelecidos para três tipos de produtores, e com base em alguns dos indicadores culturais de soberania alimentar

obtidos por meio da Pesquisa-Ação Participativa (PAR) para uma tese de doutorado, as características dos três elos do processo de produção do arroz, com dados compartilhados por os agricultores participantes sobre sua atividade econômica principal para identificar os fatores de dependência e de tomada de decisão, como chaves a serem consideradas para a construção da sustentabilidade do sistema ao qual pertencem, desde as realidades que vivem e enfrentam diário.
Palavras-chave: Sustentabilidade. Sistemas agroalimentares. Desenvolvimento sustentável. Agroecología.

Capacidad de resiliencia de pequeños productores de arroz en Colombia y sus implicaciones para la Soberanía Alimentaria en el contexto pandémico

Resumen

El presente trabajo es resultado de la colaboración entre dos tesistas comprometidos con el campo latinoamericano, interesados en realizar un análisis de la capacidad de resiliencia de pequeños productores de arroz en Colombia y sus implicaciones para la Soberanía Alimentaria ante un escenario de vulnerabilidad marcado por los efectos del cambio climático y el Tratado de Libre Comercio en la actual coyuntura de pandemia y postpandemia. Retomando los resultados del trabajo de tesis de maestría obtenidos mediante la metodología MESMIS aplicada con 50 arroceros del Departamento del Huila con base en el Enfoque de Medios de Vida Sostenibles (EMVS) y Marcos de Capitales de la Comunidad (MCC), se establecen puntos de resiliencia para tres tipos de productores y con base a algunos de los indicadores culturales de soberanía alimentaria obtenidos mediante la Investigación Acción Participativa (IAP) para tesis doctoral, se analizan las características de los tres eslabones del proceso productivo del arroz, con datos compartidos por los agricultores participantes sobre la realidad de su principal actividad económica para identificar los factores de dependencia y toma de decisiones, como pistas a considerarse para la construcción de la sostenibilidad del sistema al que pertenecen desde las realidades que viven y enfrentan cotidianamente.
Palabras claves: Sustentabilidad. Sistemas agroalimentarios. Desarrollo sostenible. Agroecología.

1 Current scenario: hunger, poverty and food insecurity in Latin America and Colombia

The deepening levels of extreme poverty and inequality in Latin America due to the health crisis caused by COVID 19 have set the region back 27 years, as shown by data from the Economic Commission for Latin America and the Caribbean (CEPAL), that for 2021 show an increase in the poverty rate of 13.8%, going from 81 to 86 million people in this situation between 2020 and 2021 (CEPAL, 2022), versus the 62 million recorded or 10.2% of the population in 2017 reported in the Latin American Social Panorama 2018 report (CEPAL, 2019).

According to this organization, the downward trend in inequality observed since 2002 came to an end in 2020, with an increase in the Gini Coefficient of 0.7 percentage points, reflecting a protracted social crisis that continues, as despite economic GDP growth of 6.2% experienced in 2021, the estimated relative and absolute levels of poverty and extreme poverty have remained above those recorded in 2019 (CEPAL, 2022).

For 2018, the Food Security and Nutrition Overview report directly linked economic and social inequality to higher levels of hunger, food insecurity and other forms of malnutrition such as obesity and overweight, reporting 39.3 million people

affected by hunger, corresponding to 6.1% of the regional population, assuring that these levels affect the most excluded sectors of society, such as women, indigenous populations and children in the poorest countries (FAO, FIDA, OMS, PMA y UNICEF, 2021).

Between 2019 and 2020, such levels reached their highest point since 2000 (before the food crises of 2008 and 2009), with a 30 percent increase in the number of people suffering from hunger, reaching a total of 59.7 million people or 9.1 % of the 660 million people living in Latin America. Also, in 2020, four out of ten people experienced moderate or severe food insecurity[1], for a total of 267 million people, 60 million more than in 2019, the steepest increase in relation to all other regions of the world (FAO, FIDA, OMS, PMA y UNICEF, 2021a).

Similarly, with respect to other forms of malnutrition, the Regional Overview of Food Security and Nutrition report (2021) warns that, by that year, one in four adults out of a total of 106 million people suffered from obesity, while in 2020, 7.5 percent of children under five years of age were overweight, that is, 3.9 million children in the region (FAO, FIDA, OMS, PMA y UNICEF, 2021b).

In Colombia, during 2021 the GINI coefficient reached 0.52, while poverty was estimated at 40% according to data from DANE (2022), whose analysis shows an approximate of 25.7 million people in this situation, of which a total of 19.6 million live in monetary poverty (2.1 million more than before the pandemic) and 6.1 million in extreme monetary poverty - a category that is directly related to the insufficiency of resources to afford a basic food basket that allows the intake of 2,100 calories per day, calculated at 161,009 COP per capita -, with an increase of 1.4 million people in relation to 2019.

In rural Colombia, by 2021, approximately 86,340 more people entered into extreme monetary poverty, with an incidence of 18.8% with two million people in this category, while monetary poverty increased by 1.7 for a total of 4.9 million people, which mark an incidence of this category at 44.6%, with the greatest variation in the department of Huila, in terms of monetary poverty with 11.9 percentage points from 55.6% in 2020 to 43.7% in 2021 and in terms of extreme monetary poverty with a reduction of 8.1 percentage points from 22.1% in 2020 to 14.0% in 2021 (DANE, 2022).

In the absence of data from the National Survey of the Nutritional Situation (ENSIN) for 2021, according to *El País* (2022), the latest study by the National Food Bank Network (ABACO) and the Chamber of the Food Industry of the National Association of Entrepreneurs (ANDI), reported for 2021 54.2% of the Colombian population living in food insecurity and more than half a million children, 10.8% of those under 5 years of age with chronic malnutrition, attributing these figures to the Covid-19 (Mahtani, 2022).

[1] According to FAO (n/d), hunger is a painful physical sensation caused by an insufficient intake of food energy and becomes chronic when a person does not consume a sufficient amount of calories on a regular basis for a normal, active and healthy life. Severe food insecurity refers to people who have run out of food or have gone a day or more without food, while those experiencing moderate food insecurity have reduced food quality and/or quantity and are unsure of their ability to obtain food due to lack of money or other resources. The latter may increase the risk of some forms of malnutrition, such as stunting in children, micronutrient deficiencies or obesity in adults.

2 Resilience as an international solution strategy

Currently, CEPAL (2022) states that regional figures make Latin America and the Caribbean the most vulnerable region in the world in the face of the pandemic situation, and therefore states that the eradication of poverty and the reduction of inequality in all its dimensions are the central challenges for Latin American countries and makes an urgent call to advance towards universal, comprehensive, sustainable and resilient social protection systems.

Coincidentally, in 2021, agencies of the United Nations system, such as the Food and Agriculture Organization of the United Nations (FAO), the Pan American Health Organization/World Health Organization (OPS/OMS), the United Nations Children's Fund (UNICEF) and the World Food Program (PMA), are urging action to halt the increase in hunger, food insecurity and malnutrition in all its forms, urging the countries of the region to take measures to transform their agrifood systems and make them more efficient, resilient, inclusive and sustainable, in order to provide sufficient and healthy diets for all. (FAO, FIDA, OMS, PMA y UNICEF, 2021a).

Resilience and sustainability are thus positioned as international strategies to overcome the current situation of poverty, inequality, hunger and food insecurity in Latin America, which is why, on November 23, 2021, Colombia signed the Pact for the Grand Alliance for Nutrition and Zero Hunger in Latin America and the Caribbean, together with nine countries in the region, in order to accelerate progress in meeting the targets of Sustainable Development Goal 2; Zero Hunger (PRESIDENCY OF THE REPUBLIC OF COLOMBIA, 2022).

In addition, according to the Presidency, Colombia works its Food Security process through the Great Alliance for Nutrition, which articulates the government with actors from the private sector, academia, civil society and international cooperation, setting goals around the action driven by the 2030 Agenda on eradicating malnutrition and strengthening food systems. However, according to *Fundación É*xito, the outlook is not easy for the fulfillment of these commitments, as evidenced by the progress in the eradication of chronic child malnutrition, one of the main goals committed for 2030, which before the pandemic was already six years behind schedule and is currently expected to be viable until 2040 (MAHTANI, 2022).

Similarly, as support to the Colombian Government in its efforts to achieve sustainable development, the PMA, through the Strategic Plan for Colombia (2021-2024) in line with the United Nations Cooperation Framework for Sustainable Development 2020-2023 and the National Development Plan "Pact for Colombia, Pact for Equity", has set as one of the three strategic outcomes for 2024, the strengthening of public policies, institutional capacities, systems and services for the promotion of food security, nutrition and social inclusion for permanent access to adequate and nutritious food by vulnerable populations.

For this purpose, PMA foresees a cost of 654,322,693 dlrs. EE.UU., through a close strategic and operational partnership and coordination with the Government and its institutions at the central and local levels, as well as with United Nations agencies, academic institutions, non-governmental organizations and civil society, in order to achieve the expected results and contribute decisively to the achievement of Zero Hunger and the end of malnutrition in the country (PMA, 2021, p. 3).

PMA (2021) identifies as main factors jeopardizing good results, in addition to extreme natural phenomena and climate change, "violence caused by illegal organized armed groups and the presence of illegal economies" (p. 1), and as main

opportunities those linked to the management of humanitarian emergencies, the strengthening of the livelihoods of populations affected by violence, climate change and other types of crises and "the creation of development opportunities, the strengthening of public policies on food security and nutrition and the improvement of institutional capacities to serve the most vulnerable populations" (p. 2).

Likewise, the United Nations Cooperation Framework for Sustainable Development Colombia (2020-2023), indicates among the main challenges for sustainable development in the National Development Plan (PND), the "stagnation of productivity; labor informality; population and regional gaps; limitations in access to quality basic services; violence caused by illegal armed groups; the existence of illegal economies and vulnerability to disaster risks and climate change" (UN, Colombia, 2020, p. 9).

In this regard, the reports of the Intergovernmental Panel on Climate Change (IPCC, 2014, 2018) point to anthropogenic activity as the cause of the disproportionate increase in greenhouse gas emissions and the resulting global warming, pointing to indigenous peoples and local communities that depend on agricultural livelihoods or coastal areas, as the most vulnerable populations to a global warming of 1.5°C or higher, a rate estimated to be reached between 2030 and 2052, if it continues to increase at the current rate (IPCC, 2018).

For that matter, the 2019 Global Hunger Index (GHI) report highlights the link between hunger and climate change, ensuring that all manifestations of climate change have direct and indirect negative effects on food security through changes in food production and availability and instability of food systems, for example, extreme weather disasters that reduce yields of major crops, impacting on increased food prices and loss of income, which mainly harms access to food for low-income people, recommending to enhance the resilience of affected communities and develop national approaches to food and nutrition security (GLOBAL HUNGER INDEX, 2019).

Finally, the IPCC (2022) reports having reached a global warming of 1.1°C thanks to the use of coal, oil and gas as energy sources for human activities and warns about the consequences of climate change, in addition to those related to temperature, changes in humidity and dryness due to the intensification of the hydrological cycle that affects rainfall patterns and causes precipitation and associated floods, as well as droughts, which directly affect the quantity and quality of cereal production in the world.

3 Vulnerability and resilience of rice farmers in Colombia

According to the Strategy for Information, Education and Communication on Food and Nutrition Security for Colombia, developed by FAO and the Ministry of Health and Social Protection (MSPS) in 2016, rice is among the 10 most consumed foods, included in the list of priority foods and characteristic of consumption patterns in different regions of the country, being part of the Colombian food culture, which "is an important component of food security, as it allows to know the behaviors, attitudes and habits towards food consumption" (MSPS, FAO, 2016, p.5).

With a current per capita consumption of 44 kg in rural areas and 52 kg in urban areas (FEDEARROZ 2022), rice is the third largest agricultural product in extension after coffee and corn, with a share of 5% in agricultural GDP and 1% in the family basket, and is the second food with the highest share in the Consumer Price Index (IPC) with 1.75% after meat (MINISTERIO DE AGRICULTURA, 2017), which positions it

as a key cereal for the country's food security. The total area planted with rice in the country in 2021 was 544,635 hectares (ha), with a national production of 3,326,529 tons (t), the main rice-growing areas being the Eastern Plains (44%) and Tolima and Huila (29%) (DANE - FEDEARROZ, 2022a).

It is the main large-scale, short-cycle crop in Colombia, whose production system has been transformed into two: mechanized and traditional (handmade or *chuzo*). Mechanized rice is subdivided into irrigated and rainfed; irrigated rice is that whose water resources are provided by pumping or gravity from irrigation districts, while rainfed rice depends on water from rainfall recovered through drainage canals (FINAGRO, 2017). According to MAZUERA; NEIRA (2009), the handmade way of sowing rice, or chuzo, has been disappearing due to its high production costs and low productivity due to inappropriate use of water, pest and disease control mechanisms and fertilizers, with yields ranging between 1 and 2 tons compared to the 5.7 tons of the national average of mechanized rice (DÍAZ; TORO, n/d).

Historically, rice yields vary depending on factors related to environmental supply, technological innovation and planting time, and in recent decades, factors associated with global climate change, which generates an increase in temperature and variation in rainfall patterns, have had a direct and indirect effect on the rice production system, reflected in low yields due to water shortages and, in some areas, flooding (CASTILLA, 2021).

According to the results of this study, in 2017 the ideal temperature for rice cultivation in Huila is optimal between 24°C to 28°C daytime hours and no lower than 20°C nighttime hours. Increases in temperature affect crop phenology and yield, accelerating the ripening process with loss of flowering and decrease in weight and grain quality. Temperatures between 28°C and 34°C affect the reproductive stage because during flowering and anthesis they produce precocity, leading to the formation of immature pollen without possible fertilization, which can contribute to an increase in the percentage of sterility of the spikelets (GONZÁLEZ ET AL. 2004).

Crop phytosanitation is also compromised by high temperatures and relative humidity that favor the proliferation of pests and diseases, in addition to facilitating their spread between regions, as is the case with the bacterial panicle blight, caused by Burkholderia glumae, which has increased its incidence in recent years (PÉREZ; SAAVEDRA, 2011). In addition, its highwater requirement -approximately 5,000 liters of water to produce 1 kg of rice or between 10,000 and 20,000 m3/ha depending on the efficiency of use-, makes it necessary to use irrigation districts in areas such as Huila and Tolima, unlike the Eastern Plains, which have heavy rains between April and May (AQUAE, FUNDACIÓN, 2022).

In Huila, rice production has limitations due to the water deficit, causing a decrease in the planted area of 6,718 ha between 2016 and 2021, from 38,439ha to 31,721ha with an impact on production of 12,407t, going from 258,684t to 246,277t in that period. According to the farmer José VALEN GARCÍA, participant of this study: this reduction implies for the farmer 3 packages of 62.5 kg of green paddy less per ha, about 327,000 COP less that the producer would spend to pay 6.5 days of work at 50,000 COP in a week of work per family, which no longer receives that income. In his own words:

> Currently the price of rice is 218,000 COP per load (2 packages of 62.5kg) depending on the crops of Los Llanos, the price of rice in the central zone can fall depending on supply and demand, because when there is a lot of rice production in Los Llanos, the price falls in the central zone

> because there is no storage capacity for overproduction. Currently, Urea, the most used fertilizer, is applied between 180 and 200 kg per ha, the 50kg bag costs 270,000 COP, which means that it has gone up 4 times more than in 2019 which cost 78,000 COP. The seed of which 3 bags per hectare are used FEDEARROZ 2000 variety, today it costs 176,000 COP per bag, compared to the cost of 150,000 COP in 2019. If we add to this the fact that there is no available labor force, since young people do not work in the fields, planting and harvesting becomes difficult, and the sown area has to be further reduced or only sown for a semester, since there is no one to remove the weeds, and there is no means to pay for fertilizer; it has to be bought on crop loan; Do you know how much a farmer spends on his weekly market? At least 250,000 COP! (Personal communication, May 9, 2022).

Valén García cultivates between 5 and 12 ha, which is the average in the central zone with mechanized irrigated crops, compared to the minimum average of 100 ha planted in the Llanos with rainfed crops. In the central zone there are more producers, but with much less cultivated area than in the Llanos, however, production in the Llanos is completely dependent on rainfall.

In the central zone, formed by the Departments of Tolima, Caquetá, Cauca, Cundinamarca, Huila, Nariño and Valle del Cauca, at the time of the field work of this research, the IV National Rice Census (FEDEARROZ, 2016), reported a production achievement of 1,011. 454 tons of green Paddy Rice, in 140,919 hectares, with an average yield of 5.3 t/ha in rainfed and 6.9 t/ha in irrigated, compared to 2021, with a production of 1,064,266 tons of green Paddy Rice, in 127,573 hectares planted with mechanized rice, with an average of 5 t/Ha in rainfed and 7.3 t/Ha in irrigated (DANE-FEDEARROZ, 2022b).

According to this same census, in the case of the Department of Huila in 2016, rice cultivation represented one of the main agricultural activities, covering 25% of the area of the central zone and 7% of the country. Average yields were calculated at 7.5 t/ha (compared to 5.7 nationally), with an estimated 1,513 producers directly and indirectly generating income from this productive sector through 2,413 Rice Producing Units (UPA), with a reduction of 51,778 ha of sown area by 2021 (-25.2%) and 97,590 t of total annual production (-2.5%) compared to 2020 (DANE - FEDEARROZ, 2022).

Table 1. Production and yields in the Department of Huila 2016-2021

Year	Planted area in Huila	Annual production (t)	Yield (ha)
2016	38.439	258.684	7.5
2017	33.593	266.210	7.2
2018	34.286	237.186	7.3
2019	32.798	249.024	7.6
2020	38,654	260,013	7,4
2021	31,721	246,277	7,3

Source: DANE, Mechanized Rice Survey (ENAM) Historical 2016 to 2021.

It is in this scenario that Colombian rice farmers develop their activity; Considering that in the department of Huila rice production is in the hands of different types of producers, this study provides an overview of the resilience

capacity of rice producers and their production system, using the MESMIS methodology, Evaluation Framework for Natural Resource Management Systems Using Sustainability Indicators, to establish resilience points by farmer typology through the application of fifty surveys to rice farmers in the villages of Polonia and San Alfonso, in the area of Villavieja, belonging to the Amazon inter-Andean corridor as stipulated in the Land Management Plan POT of 2017.

4 Methodology

The study was conducted from June to October 2017, in three phases. The first, to obtain the characterization and typification of rice production systems, using multidimensional and multivariate analysis methods with different methodological routes organized in the following moments: (1) Description of the population with information collected from primary sources, mainly from the Economic Department of FEDEARROZ and the Irrigation Districts of ASOPORVENIR and USOALFONSO; (2) Sample selection through surveys and semi-structured interviews; (3) Design and validation of the data collection instrument, based on the Sustainable Livelihoods Approach (EMVS) and Community Capital Frameworks (MCC); (4) Data collection and processing; (5) Determination of the total number of variables and their classification; (6) Information analysis through the application of multivariate statistical techniques; (7) Determination of the type of rice systems using statistical methods and; (8) Description of the obtained typology.

In the second phase, the resilience capacity of rice producers and their production systems was analyzed using the MESMIS methodology at six points in time: (1) Definition of the object of evaluation; (2) Determination of critical points for resilience; (3) Selection of diagnostic criteria and indicators that are easy to measure, simple and clear to understand; (4) Measurement and monitoring of indicators through the application of instruments; (5) Presentation of results in graphs, using qualitative and quantitative techniques and; (6) Conclusions and recommendations in a workshop with participants.

5 Results

Characterization and typification of producers

The 50 participants are classified into three types of producers: 1) Visionaries 2) Small Traditionalists and 3) Business. The first type "visionaries", corresponds to 9 farmers comprising 18% of the participants, characterized by being small producers with between 5 and 10 ha, who live informed of projects and laws that favor their activity, implement input saving techniques, such as pools, are linked to an association of users such as the irrigation district and organizations such as the mills, which allows planning of their planting and working capital without being obliged to bank loans because they have their own savings. They belong to other organizations that facilitate crop stability, such as the Community Action Boards, have technical assistance from the mill to determine no-tillage plantings, and use 100 kg of seeds per hectare. In general, they are farmers who are looking to innovate by adapting new technologies such as the reduction of seed for planting while maintaining FEDEARROZ links. Access roads to the farm are secondary. Their family nucleus is 4

to 5 people. They do not share their knowledge, although they do embrace innovation.

To the second type, "Small Traditionalists", belong 20 farmers (40% of the participants). They are characterized as small farmers with less than 5ha, both in terms of farm area and the area planted in rice. They belong to organizations such as *Agropecuaria la Victoria*, which provides them with technical assistance and input sales. Their commercial ties are linked to small warehouses, and they do not handle information on support programs and projects or laws that may affect their crop. Land tenure is particular (inheritance or other type of tenure), they are not linked to districts because they use their own or community tributaries, nor to FEDEARROZ; their family nucleus is 2 to 3 people and the access roads to the farm are tertiary.

Finally, in the third group, "business", 42% of the producers are located, 21 participants who manage areas of more than 20 hectares for rice cultivation and their farms are large. Although they do not handle the laws or programs for the crop and the lack of training prevents the adoption of new technologies such as AMTEC, they do receive technical assistance for the planning of the planting work and optimize the time of the farm, which is why many of the crops are conventionally irrigated and with high seed densities, around 250 kilos/ha, they are beneficiaries of bank loans, have accountants, belong to commercial organizations, among them mills and irrigation districts; although their access roads to the farm are tertiary, they have their own means of transportation.

The following table shows seven components taken from Sustainable Livelihoods Approach and Community Capitals: human, natural, physical, financial, social, cultural and political, subdivided into 26 variables to categorize the type of farmer interviewed.

Table 2. Characterization and typification of 50 rice producers in the two villages of Villavieja - Huila

Sustainable Livelihoods Approach	Variable	Category	Number of producers
Human	Education Level	High	3
		Medium	22
		Low	25
	Training	Technical	34
		Other training	2
		No Training	14
	Technical Assistance	Before Cultivation	37
		After Cultivation	8
		Punctual	3
		No Technical Assistance	2
Natural	Land tenure	Own	32
		Lease	16
		Other types of Land T.	2
	Total Farm Area	< 5 Ha	13
		5-10 Ha	12
		10 -20 Ha	8
		21 -50 Ha	12
		>50 Ha	5
	Rice area	< 2 Ha	6
		3 - 5 Ha	8
		5 - 10 Ha	14
		10-20 Ha	8
		20 -40 Ha	10
		> 40 Ha	4
	Types of Production System	Traditional	41
		Pool	9
	Types of Planting	Broadcasting	28
		Furrow	22
	Amount of seed per ha	150	11
		200	23
		250	16
	Type of Preparation	Zero tillage	7
		Traditional	38
		AMTEC parameters	5
	Amount of water M^3/ha	20.000	15
		15.000	32
		10.000	3
Physical	Tools and Equipment	Other Tools and Equip.	6
		No Tools and Equipment	18
		One tool	6
		Tractor and another tool	20
	Access roads to the farm	Primary	3
		Secondary	16
		Tertiary	31
	Means of Transportation	Bicycle	3
		Motorcycle	37
		Car	10

Source: Own elaboration with data from field research results

Table 2. Characterization and typification of 50 rice producers in the two villages of Villavieja - Huila

Sustainable Livelihoods Approach	Variable	Category	Number of producers
Financial	Source of money for rice production	Savings	9
		Mill	8
		Bank loan	33
		Family loan	0
	Records revenues	Never	11
		Notebook	27
		Computer	7
		Accounting software	0
		Accountant	5
	Credit	yes	41
		no	9
Social	Group affiliation	Irrigation District	15
		User association	4
		Communal Action	4
		None	27
	People dependent on rice cultivation	1 to 2 people	13
		3 or more people	25
		Others depend on	12
	Direct jobs	1 to 2	41
		3 to 4	9
Cultural	Share their knowledge	Yes	38
		No	12
	Factors that influence decision making	Market prices	12
		Labor availability	18
		Water availability	6
		Capital Availability	14
	There is a tradition of innovation	Yes	25
		No	25
Political	Organizations with which they have links	ORF	28
		Fedearroz	4
		Coagrohuila	6
		Agrinsa	4
		Ptc	4
		Agrop. La Victoria	4
	Knowledge of production activity programs	Yes	19
		No	31
	Knowledge of laws affecting their production	Yes	15
		No	35

Source: Own elaboration with data from field research results

Resilience levels

The following table shows 26 indicators, with different components taken from Sustainable Livelihoods Approach and Community Capitals, rated by level with values from one to five, where five corresponds to higher resilience capacity and one to lower resilience capacity of the participants to certain rice cultivation scenarios.

Table 3. Resilience levels of rice producers in the two villages of Villavieja - Huila

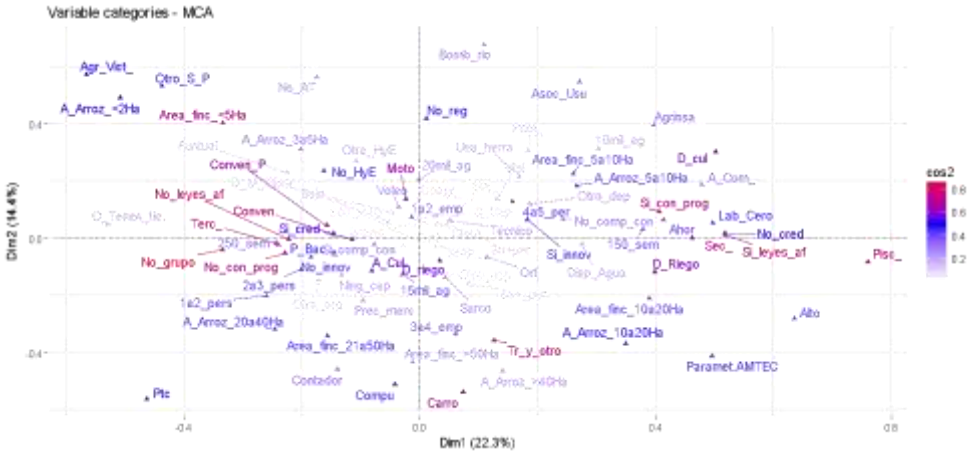
INDICATOR	RESILIENCE LEVELS				
	1	2	3	4	5
(1) Education Level	Low		Medium		High
Participants	25		22		3
(2) Training	None		Other		Technical
Participants	14		2		34
(3) Technical Assistance	None	Punctual	After Cultivation		Before Cultivation
Participants	2	3	8		37
(4) Land Tenure	Other type		Lease		Own
Participants	2		16		32
(5) Total Farm Area	< 5 Ha	> 50 Ha	21 - 50 Ha	10 - 20 Ha	5- 10 Ha
Participants	13	5	12	8	12
(6) Rice Area	< 2 Ha	3 - 5 Ha	20- 40 Ha	10 - 20 Ha	5-10 Ha
Participants	6	8	14	8	14
(7) Types of Production System	Traditional				Pool
Participants	41				9
(8) Types of Planting	Broadcasting				Furrow
Participants	28				22
(9) Amount of seed per ha	250 kg		200 kg		150 kg
Participants	16		23		11
(10) Type of Preparation	Traditional		Zero Tillage		AMTEC Parameters
Participants	38		7		5
(11) Amount of Water M^3/ha	20.000 m3		15.000 m3		10.000 m3
Participants	15		32		3
(12) Tools and Equipment	None of their own		One Tool	Another Tool and Equipment	Tractor and Tools
Participants	18		6	6	20
(13) Access Roads to the Farm	Tertiary		Secondary		Primary
Participants	31		16		3
(14) Means of Transportation	Bicycle			Motorcycle	Car
Participants	3			37	10
(15) Money for production	Bank Loan	Mill	Family Loan		Savings
Participants	33	8	0		9
(16) Records revenues	Never	Notebook	Accounting Software	Computer	Accountant
Participants	11	27	0	7	5
(17) Credit	Yes				No
Participants	41				9
(18) Group Affiliation	None		Communal Action	User Association	Irrigation District
Participants	27		4	4	15
(19) People dependent on the crop			Others depend on	1 to 2 people	3 or more people
Participants			12	13	25
(20) Direct Jobs				3 to 4	1 to 2
Participants				9	41
(21) Share their knowledge	No				Yes
Participantes	12				38
(22) Factors that influence decision making	Capital Availability		Market Prices	Water Availability	Labor Availability
Participants	14		12	6	18
(23) Tradition of Innovation	No				Yes
Participants	25				25
(24) Link to organizations	PTC and Agrop. La Victoria	Agrinsa	Coagrohuila	Fedearroz	ORF
Participants	8	4	6	4	28
(25) Knows about programs	No				Yes
Participants	31				19
(26) Knows about laws	No				Yes
Participants	35				15

Source: Own elaboration with data from field research results

Resilience capacity

The following graph, elaborated with the Coefficient of Determination (R2) program, represents the two most significant dimensions of the 10 dimensions yielded by the application of the DIMDESC function fed by the 23 variables of the seven characterization and typification components (Table 2) and the 26 indicators of the resilience levels (Table 3) corresponding to two axes: X- Horizontal Axis Dim2 (14. 4 %) and the Y-vertical axis Dim1 (22.3 %), to show the conglomerate of producers with the highest resilience capacity, which are those closest to any of the axes in any of the quadrants.

Figure 1. Resilience capacity of producers in the two villages of Villavieja - Huila



Source: Own elaboration with data from field research results

Of the 50 producers, 11 have a level 5 of resilience in the 26 indicators, meeting the following characteristics: training and technical assistance before cultivation, own land tenure, cultivation area between 5 to 10 ha, own tools, equipment and tractor, family composed of 3 or more people, employing 1 to 2 people, share knowledge with other farmers, have availability to innovate in their plot, maintain links with millers and the availability of labor is a major factor in making decisions for cultivation.

6 Implications for Food Sovereignty

Faced with the approach of international organizations to hunger and poverty and their solution strategies promoted by the World Food Summit on Food Security[2] in 1996, in the same year, *La Via Campesina* (LVC)[3] launched the concept of Food Sovereignty (SoA), as a global peasant demand that questions the sovereignty of countries in food matters in the context of neoliberal globalization, pointing out, in addition to Climate Change, the origin of food and the ways in which it is produced

[2] Term coined by FAO in 1996.

[3] International movement that brings together 182 organizations and more than 200,000,000 peasants from 81 countries according to a list updated during the VII Conference of *La Via Campesina*, held in Derio, Basque Country, July 16-24, 2017. It defines itself as a political movement, autonomous, plural, multicultural, in its demand for social justice while remaining independent of any political party, economic or other affiliation.

under the rules of the market, as the main causes of these evils that afflict humanity (TORRES, R., 2020a).

Globalized neoliberal policies have reconfigured the geopolitical map around the world food market, favoring transnational corporations and food exporting countries, through a centralized model of distribution in long chains that subject poor nations to food dependency, turning them into importers of staple foods and allocating their best lands to industrial agriculture for export (TORRES, R., 2020a); in the words of *La Vía Campesina*: "the neoliberal model, international financial institutions and transnational capital are directly responsible for the climate and food crisis" (LVC, 2009, p.74).

Due to the acquisition of large agricultural areas at very low prices by large corporations, the occupation of freshwater reserves, exploitation and contamination of other natural resources, a series of territorial conflicts have arisen, including the expulsion of the native population from their territories (TORRES, R., 2020a). As stated by LVC (2009): "Over the last few decades, the World Bank, the IMF and GATT, and then the WTO, have gradually forced all countries to dismantle all public policy tools that made it possible to maintain national food production capable of meeting the needs of the population" (p. 167).

In the case of Colombian rice, from 2016 to 2020 the planted area was reduced by 25,166 ha maintaining the yield of 5.7 (t/ha) against an increase in per capita consumption of 5.1 kg. In terms of imports, 2021 was an atypical year, as only 7,480 tons of the 117,402 tons that had been calculated were imported (FEDEARROZ, 2022a), although there is no official data on consumption in 2021, this apparent self-sufficiency is due to national inventories and a reduction in household rice consumption, due to the effect of loss of income due to health measures in the face of the pandemic as well as blockades with obstruction on national roads throughout the country during the 2021 National Strike[4] (CIAT, 2021).

Table 4. Domestic Production versus Imports

Years	Area planted with mechanized rice (ha)			National Production (t)	Yield (t/ha)	Per capita consumption (kg)			Imported white rice (t)
	Irrigation	Rainfed	Total			Urban	Rural	Average	
2016	279,014	291,787	570,801	2,971,975	5,7	39	46	42,5	276,121
2017	277,416	317,96	595,376	3,048,993	5,2	40,56	44,2	42,38	110,136
2018	257,559	243,365	500,924	2,925,557	5,7	39,78	50,7	45,24	133,861
2019	253,218	286,335	539,553	2,984,601	5,8	40,04	52,26	46,15	193,853
2020	264,089	332,326	596,415	3,415,079	5,9	44,2	52	48,1	227,611
2021	223,864	320,772	544,636	3,326,529	5,7				29,145

Source: Own construction with FEDEARROZ, 2022a; 2022c data.

[4] In protest to the Tax Reform or Sustainable Solidarity Law, for income taxes and VAT on public services. Farmers would be affected by the elimination of the category of exempt goods, which, by becoming excluded, will not receive a refund of the VAT paid along the chain for the purchase of inputs, which would force them to pass this cost on to the final product, affecting the price of the basic food basket.

Since the entry into force of the Free Trade Agreement in 2012, the Colombian government's protectionist measures have been reduced, as in the case of tariffs on imports that began that year with a tax of 80% on rice imports and will gradually decrease to zero by 2030, currently at 55% while forcing producers to exceed current national yields (5.8 ton/ha) to be competitive against the 9.5 ton/ha of US rice (MINCIT, 2022).

Since that year, the COL RICE stock exchange has been operating as an external regulator of tariff quotas for the entry of U.S. rice, through auctions to Colombian and U.S. millers. The money collected is split 50-50 between the two parties, and is used to increase the competitiveness of rice farmers by 20-30% and reduce production costs by up to 20% through investment in technology transfer, technical assistance and machinery (seeders, harvesters, taipas, land-planes, trenchers and vibratory chisel plows, among others) (FEDEARROZ, 2022b).

However, Colombian farmers, mostly small producers, do not meet the quality standards required by multinational companies, especially phytosanitary standards that include Good Agricultural Practices (BPA) for export, such is the case of the GLOBALG. A.P. Food Safety Assurance Standard, which covers the certification of elements related to food safety throughout the entire agricultural production process, from planting to packaging (GLOBAL G.A.P, 2020).

As a result of the Maputo International Conference in 2009, LVC affirms and denounces as causes of global warming and massive environmental destruction, the production, consumption and trade models of capitalist society, industrial agriculture and the development model based on the concentration of capital, since both the intercontinental transport of food and intensive monoculture and the use of chemical inputs are transforming agriculture into an energy consumer that contributes to climate change, high consumerism and free trade, as well as "false solutions" such as biofuels, carbon trading, GMO crops and trees, which only benefit transnational corporations (LVC , 2009).

In addition, the drastic reduction of public protection policy mechanisms such as tariff barriers, food reserve funds, public aid to agriculture and price control mechanisms is leading to the abandonment of domestic food production, as well as to a change in eating habits, which, thanks to fashions and advertising propaganda, have been replacing local products with diets based on non-fresh imported products (TORRES, R., 2020a).

For these reasons is that SoA claims the human value of food over its value as a commodity on the market and fights for the rights of peoples to make their own decisions on their food activity and ways of life, as well as on the management and control of pastures, water, traditional seeds, livestock and aquatic populations in the territory, and the traditional knowledge and practices they conserve, develop and manage local food systems with planting and harvesting methods that respect the rhythms of nature and maximize the functions of ecosystems, improving their resilience and adaptability as well as short marketing circuits that bring producers and consumers closer together in the territories (LVC, 2009, 2018, 2020).

In agreement with *La Via Campesina*, HOLT-GIMÉNEZ (2018), states that the food problem is structural as food systems function in association with the profit-generating logic of capitalism. In words of BARTRA (2009), the system enters into crisis due to its own structural contradictions, since in its productive process it devours in an accelerated manner more resources than nature is capable of

replenishing by itself, while it periodically self-destructs its excess productive capacity and its accumulative capacity is not enough to cover the consumption demands of the majority of the population, showing a pattern of scarcity in the midst of abundance:

> Hunger expresses a problem of excessive greed and poor distribution, but also and above all a problem of trend scarcity that -in a vicious turn of events- encourages speculation. And it is this growing and ominous deterioration that makes the food crisis a substantial part of the multidimensional civilizational collapse that afflicts us (BARTRA, 2011, p. 13-14).

Likewise, MOORE (2020) asserts that the current environmental problems are not caused by the Anthropocene but by the Capitalocene, that is, by the accumulative patterns that govern capitalism both in production and consumption without limit, as well as in the unequal distribution of the wealth generated and the environmental and social costs of this model translated into socio-environmental injustice. This aggravates the gap of economic inequality caused by the search for unlimited growth, which makes the productive processes for the economic growth of countries require the consumption of more and more nature, which, objectified thanks to the idea of the human being-nature separation derived from Cartesian dualism, is assumed as an exploitable and manipulable resource for human exploitation for the sake of the welfare and development of modernity (TORRES, R., 2020b).

In this way, the logic of capitalism and its pattern of unlimited growth unbalance the energy flows of living systems, exceeding the limit of the earth's carrying capacity, which is expressed in an environmental crisis that puts the survival of our species at risk (LANDER 2011). These dynamics generate simultaneous crises in the different areas of human life that converge in a multisystemic and globalized manner, which, for authors such as BARTRA (2009), ESTERMANN (2012), LANDER (2011), LEFF (2008), TOLEDO (2012), among others, are signs of a civilizational debacle that marks a historical turning point in humanity, of such magnitude that it is urgent to rethink the pattern of development and the idea of progress based on economic growth, which shows that it has reached its limits.

From this economic rationality, when the inputs of nature reach their physical limit point of non-feasibility for exploitation, technological innovation is used as the most important instrument for the renewal of capital; however, scientific and technological advances cannot replace the natural processes that generate and regenerate life, so they will always require some type of energy, without considering the effects of destruction and a new production of scarcity on a new scale, in this case on a global scale (LEFF, 2008). For this reason, it cannot be said that the rice production system can be sustainable, as shown in Table 5, whit the results of the analysis of the implications for food sovereignty of the rice chain in Huila.

Table 5. Implications for food sovereignty by production linkages

Primary link (procurement and primary production of green paddy rice)	
Crop characteristics	In the eastern plains area, we speak of large-scale monoculture due to its large areas of more than 100 ha, while in Huila, especially in Villavieja, where each 5-hectare plot is generally owned by a different producer, we speck of subsistence cultivation. It is considered that a family can live well by producing 5 hectares with an average yield of 7.5 t/ha. The total harvest is for sale, which provides the income to buy the food that the family consumes daily, since they do not grow other types of food. Implication **(I): Rice farmers depend entirely on the sale of their harvest to feed their families**
Land access	Hectareage between 5 and 10 ha, mostly owned **I: A farmer with less than 5ha cannot engage in this activity**
Water access	Between 10,000 and 20,000 M3/ha are required, which are supplied by the Asoporvenir and Uso Alfonso districts; the farmer is limited to planting according to the water allocation of the districts. **I: The highwater requirement forces the farmer to depend on an**
Access to Supplies	Most used seeds: Fedearroz 2000, 67, 68, 2020, Maja and Oryzica 1 (between 100 to 200 kilograms/ha). $120,000 COP per ha, no native seeds used. Agro inputs: Fertilizers such as Nitrogen 180 kg/ha (Urea), Phosphorus 40-50 kg/ha (Rafos, Map, Dap). Potassium 120-140 kg/ha, (Kcl, Korkacall, Pantecall) and a range of insecticides (pyrethroids) Fungicides (Strobilurins) and systemic herbicides (glyphosate) contact (Paraqual) and post-emergent (Butacior) and contact (Propan). **I:High dependence on high-cost agrochemicals. The producer depends on loans from the mills (with 1.2% interest per cycle) to cover planting expenses, for advance payment against cultivation of more than 35 days**
Mechanization	Tatu planters, semeato, Kubota DC70 and John Deere C110 combines are used, the harvest is transported to the mill in green by truck for COP 30,000 perton. The Alfonso Use District rents agricultural machinery to the farmer. Between two farmers, they rent machinery to work the lots, but it is inefficient for everyone because the work must be done in good weather conditions to avoid soil compaction. **1: Dependence on (rented) machinery for planting and transporting the crop**
Institutional support	AMTEC: FEDEARROZ provides Technical Assistance for the Massive Adoption of Technology for crop management to increase productivity and reduce production costs. The rice development quota: 0.5% of the sale price of each kilogram of paddy rice, administered by FEDEARROZ, for research and technology transfer in favor of the producer. The Dane FEDEARROZ agreement with which the national survey of mechanized rice (ENAM) is available to the farmer. The fund for Financing the Agricultural Sector (FINAGRO) is a government resource for banks to grant loans to farmers for labor and the purchase of Inputs at semiannual payments. These are set depending on whether the farmer is a large, medium or small farmer and whether he meets the requirements and has a good credit history. **I: Training and technical assistance is aimed at the mass adoption of technology offered by the providing agency**
Crop diversification	Rice is planted on the entire area twice a year. Some farmers plant lemon and cotton in other plots; no vegetables, beans or com are planted. **I: Does not promote biodiversity or food diversification for self-consumption**
Collaboration or exchange between farmers	There is no associativity; rather, there is an increase in associated value. Technical advisory services are provided in scheduled meetings for all users in a district where talks are given on the damage caused to rice crops by different pests and diseases and the product or technology is supplied to counteract the damage. On the part of the government, meetings are held with the agrarian bank about a soft credit line of great access to the farmer, but not a way to own the business.
Secondary Link (Paddy Green to White transformation)	
Main actor: Mills and processing companies The second link is the transformation process from green paddy to white rice. The main white rice distribution companies are the industrial millers, Rice Industry Federation, National Rice Millers Association and companies that receive green paddy from farmers in Huila who, lacking sufficient capital for planting, request a line of credit to receive cash advances to finance production and harvesting. These entities provide technical assistance for the crop and supply the necessary inputs that must be paid for at the end of the harvest. This, together with weather conditions that lower yields, are factors that determine the success of the harvest. The mills and rice companies such as ORF and DIANA, dry, clean and store the rice and then carry out the process of hulling, whitening, polishing and packaging in order to be marketed in different forms and presentations to the final consumer. **I: The farmer has zero participation in this process, he delivers the totality of his harvest because the green rice, due to its percentage of humidity, is not suitable for storage at home, turning their product into raw material for the food industry.**	
Tertiary link (Distribution and marketing of white rice)	
Main actor: Rice companies with commercial brands, wholesale distributors and any type of marketer in general The most common distribution channels are the sale of white rice in bulk at the wholesaler's plant door, which is then marketed in the central supply centers to retailers and/or companies that have their own recognized brand name in the market, such as Roa, Flor Huila, Diana and Arroz del Campo (FEDEARROZ's own brand), among others. These are distributed to the various points of sale by their own means or through distributors, and are currently sold to consumers at COP 2,000 per pound. **I: The farmer has zero participation, which distances him from the consumer and makes him only a consumer of his own processed production.**	

Source: Own elaboration with data from field results

This is why, for LA VIA CAMPESINA (2009), the "supposed solutions based on increasing the yields of agricultural production through the increased use of fertilizers or GMOs to feed the population" (p. 166), not only do not solve the problem at its root, but become excuses to promote the production model that increases the power of agrochemical industries. In this sense, this is a political problem, as a result of a global agrifood order that puts the interests of capital power in the hands of transnational corporations above human life, food systems and land-based livelihoods, deeply damaging food sovereignty and social sustainability in poor countries (TORRES R., 2020a).

In view of this, and since "no technological solution will solve the ecological and social disaster", LVC (2009) proposes as "the only real solution to food sovereignty" (p.67) as a fundamental approach to provide the necessary means of subsistence, while protecting the life of the earth, where "the fair and equitable distribution of food and necessary goods, together with the reduction of unnecessary consumption should be central aspects of the new development models" (LVC, 2009, p. 80).

To achieve this, LVC calls for a change in agricultural policies around the world, reorienting them towards the construction of a sustainable rural world based on Food Sovereignty and integral agrarian reform; the promotion and development of responsible consumption models and "the explicit support of governments and institutions to the sustainable, peasant-centered model for food production and distribution, with its minimum energy use, its capacity to generate employment, its respect for cultural and biological diversity and its positive effect on global warming, since fertile soils and biodiversity are the best way to capture CO2 (LVC, 2009, p. 89).

7 Conclusions

The analyses carried out in this study show that, although TPA and Climate Change affect the rice producer, there are other factors associated with the system that make them even more vulnerable, related to state policies and the abandonment of the countryside by the State, since capital investment is not direct to the farmer but through credit institutions and business entities dedicated to technology transfer and services for equipment and machinery.

The 26 resilience level indicators established in this research serve as a framework for rice farmers to calculate their own resilience capacity, assess their strengths and make decisions regarding their weaknesses. However, this resilience capacity, even at the highest level, does not help them reduce the high dependence on external resources and to make decisions on what, how much and how to plant, two of the main factors for building food sovereignty.

The high dependence starts from agricultural inputs such as water, land rental, seeds, agrochemicals, machinery, fumigation equipment, transportation, to mills and companies that process paddy rice and distribute white rice, as well as loans and advances to finance its cultivation, and ends in the dependence to buy all the food consumed daily by the family (including white rice).

The farmer's decisions are limited from the beginning of the cultivation, since both the seed and the crop protection products, the technical assistance to receive, the indebtedness and to whom he will sell his harvest depend on the rice agroindustry, as well as the payment he will receive for his harvest is determined by the law of supply and demand.

For the small farmer, rice is a subsistence mechanism, while for the large farmer it is an agribusiness. The sustainability of rice cultivation is far from being achieved as long as the same model of production, processing and sale is maintained.

An alternative is to adopt agroecology, but not only as a set of environmentally friendly techniques, but also as an alternative epistemological proposal to the dominant one and a political stance against the global food system, which deeply harms the most vulnerable populations socially, culturally, economically and environmentally, widening the socio-environmental gap expressed in hunger and poverty.

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