Original Research Article

TECHNOLOGICAL CONDITIONERS OF CASSAVA PRODUCTION IN CAMPOS DOS GOYTACAZES - RJ

ABSTRACT

This study analyzes the technological conditioning factors of cassava production in the municipality of Campos dos Goytacazes-RJ, seeking to elucidate the limitations and technological barriers that have contributed to the decline of crop production and productivity. A descriptive and quantitative methodology was adopted, in which the Survey method was used to analyze the technological factors through a questionnaire applied to 157 cassava producers in the field. The results evidenced the low degree of modernization of cassava in the municipality of Campos-RJ, intensive and extractive land use, generally produced on a small scale and with a low level of capitalization and productivity of work and land. This context seems to stimulate a vicious cycle, of low performance of the crops and profitability, low capacity of accumulation of resources, and capital and technological possibilities, favoring a gradual process of discouragement of the production. Without the possibility of gains and accumulation of income, the degree of uncertainty and risk tend to increase, as adversities and external forces make the permanence and perpetuation of the activity even more difficult, to emphasize the climatic factors and obstacles of commercialization and market. Thus, the research reinforces the need to evaluate technological alternatives that fit the local culture, as well as mechanisms that make them accessible to producers, such as: technical assistance, rural credit, social organization, among other public policies which aim to reduce the aggravation of rural activity in the municipality.

Keywords: Cassava production chain; Technology; Productivity;

INTRODUCTION

Growth of cassava, also known as *macaxeira* or *aipim* in Brazil, has a great importance on World and Brazilian agriculture, mainly, because of its scope and role in society. Cassava is widely spread by family farming, due to its peculiar characteristics. Besides it is an abundant energetic source in human and animal alimentation, presents enormous rusticity and capacity of adaptation, being able to be harvested almost during all the year. This fact allowed cassava to be explored in practically all Brazilian regions, with only family agriculture accounting for 76% of national cassava production

(SOUZA *et al*.,2012). Considering this, it is not by accident that cassava is an expressive culture in the municipality of Campos dos Goytacazes, constituting an important source of income and subsistence in small farms.

Nevertheless, agri-food consumer markets have become increasingly demanding, which tends to increase significantly and gradually becomes this market segment homogenous and focused (BATALHA & SILVA, 1999). We also highlight the concern with sustainability of rural activities, since they are inserted in economies logics and national competitiveness. This requires implications in the improvement of processes, new technologies, products and market strategies, which aim to correspond to new dynamic of competition and social responsibility (DEIMLING, et al.2015).

It was observed that cassava production chain in Brazil showed stagnation of total production, productivity and planted area indicators in recent years, compared to global scale (IBGE, 2017), while Campos dos Goytacazes-RJ has presented an accentuated decline in production indicators. According to IBGE (2017), in last 10 years, there was a drop of 69.2% in production volume caused by a reduction combination of 41.1% in cassava cultivation productivity and 47.6% in planted area in the municipality.

Vilpoux (2008) emphasizes that low level of investment in agronomic research aimed at the generation of technology and low qualification of productive management contributed to the loss of competitiveness in Brazil. Felipe et al. (2010) also discuss “besides the lack of formal contracts on supplying raw material in starch production industry, low technological level of productive systems restricts the development of the sector”. Adoption of technology on agriculture is directly related to economic performance of family production units. In addition to increasing the level of labor productivity and total productivity of the factors of production, it allows to establish upstream and downstream linkages in agriculture, which may impact the sustainability of agricultural activity (FILHO, BUAINAIN et al., 2011).

Production difference can be observed in the productive heterogeneity between Brazilian regions, which demonstrates that there is a technological dichotomy that directly affects the performance of the crops. While São Paulo and Paraná have means which registered, in 2016, 23,587 and 26,364 kg/ha in productivity, respectively, the municipality of Campos-RJ has returned productivity from 18,000 kg/ha in 2008 to 9,593 kg/ha in 2016, falling below even the average productivity in Brazil of 14,992 tons. /ha (IBGE, 2018).

Faced with this phenomenon, low use of technology is assumed to be contributing considerably to low productive and financial performance of the crops, creating a vicious and gradual cycle of discouragement of production, although one cannot disregard other external aspects. Feiden (2001) asserts that rural family sees a financial profitability of the activity as a decisive factor for its continuity. This result is a reflection of productive organization, the know-how, the technology and the dynamics that it establishes with external environment, for example, climatological conditions, market, commercialization, etc.

The analysis of the use of technology in production of cassava makes it possible to understand the limitations and technological obstacles that affect productive performance, income generation capacity and sustainability of the activity in the municipality studied, which motivates and leads the central questions of this work: what is technological standard of cassava producers in the municipality of Campos dos Goytacazes? How have these technological factors limited and impacted the performance of cassava production in the region?

In sum, the central objectives of this study was “to analyze technological conditioners of cassava production and its impacts in productive performance in Campos dos Goytacazes-RJ”.

METHODOLOGY

To analyze technological conditioners of cassava production and its impacts in productive performance in Campos dos Goytacazes-RJ, this study adopted procedures of descriptive research, aiming to accomplish a survey of characteristics and factors of production that affect the sector. A quantitative study was adopted, which was supported by field research with cassava producers. Survey method of research was used through utilization of questionnaire considering the technological determinants of cassava production that affect productive performance. In order to accomplish validation and reliability of information, the questionnaire was submitted to analysis of professionals and competent bodies, such as EMATER-RJ regional office, Municipal Secretary of Agriculture of Campos-RJ and Northern Fluminense State University Darcy Ribeiro. Subsequently, pre-tests of the questionnaire were performed in the field, with the purpose of adapting it to objectives and object of study.

The research area encompassed the whole municipality of Campos dos Goytacazes-RJ, adopting a subdivision of four large regionalized areas, respecting peculiarities and geographical divisions, as listed in Table 1. According to Rural Producer Registry of Municipal Department of Agriculture of Campos-RJ, it is estimated that the municipality has 1681 producers who cultivate cassava for subsistence or source of income, which are distributed in the defined geographical areas (Table 1).

Table 1 – Distribution of cassava producers and researched producers in Campos dos Goytacazes – RJ.

Area	Region	Producer	Researched	%
1	Santa Maria, Santa Eduarda, Morro do Coco and Vila Nova	300	28	9.3%
2	Travessão, central region of urban area of Campos	439	49	11.2%
3	Morangaba, Ibitioca, Serrinha, Dores de Macabu	456	44	9.6%
4	Tocos, Goytacazes, São Sebastião, Santo Amaro and Mussurêpe	486	36	7.4%
	Total	1681	159	9.3%

Source: Author.

As presented in Table 1, the survey obtained a 9.3% sample of universe of estimated producers, although, according to EMATER technicians, Municipal Department of Agriculture and researched producers, there is an expressive number of producers that stopped producing cassava. Mainly, reasons presented were: (1) difficulty in production commercialization and outflow; (3) oscillation and low prices in market and; (3) climatic conditions, due to heavy drought in recent years, which is an even more relevant sampling of cassava producers.

Field survey was based on sampling for analytical generalization to the municipality, which required special attention on identification and sampling process, and selection criteria of the producers. Identification and sampling process were accomplished from Rural Producer Registry provided by Municipal Department of Agriculture, which enabled interviewed producers to be identified from the database of 1,681 cassava producers registered. Some selection criteria were adopted aiming at delimiting the object of analysis, such as: (1) being a cassava producer for more than 2 years; (2) have cassava as one of main sources of income and/or subsistence; (3) have produced in last 2 years.

Schedules of collective meetings with producer groups were adopted in all four regions, followed by on-site visits at the farms, for achieving field research. Producers identification and classification was accomplished through partnership and joint initiative of Northern Fluminense State University Darcy Ribeiro, local office of EMATER-RJ, Municipal Secretary of Agriculture and producers' leaders and association presidents, which allowed to mobilize producers and to have meetings with producer groups and on-site interviews on farms.

Data analysis was limited to explanation and diagnosis of technological factors which are supposed to affect, isolated or conjunctly, cassava production performance, and, supposedly, has been influencing the gradual decline of the production of the municipality.

RESULTS AND DISCUSSION

Technological aspects were classified and related according to their nature and technical enchainment of production line, which involved the following parameters: *(1)* soil conservation; (2) soil preparation and use of equipment; (3) spacing and variety of cassava; (4) fertilization management; (5) pests and diseases management and control, as will be presented in following topics.

Analysis of the dimensions of rural properties occupied with cassava revealed a characteristic profile of producers with small extension of land. It was also verified that producers grow cassava in small areas in the property, which occurs naturally by the own limitation of size of the property and other agricultural purposes, such as breed beef and milk cattle, sugarcane and corn.

According to Table 2, the average area of properties of interviewed producers was 11.7 ha. It is highlighted in this area the relevant number of producers (68%) that cultivate cassava in a space up to 2 ha, of which 41% produce in up to 1 ha, emphasizing production limitations and use for subsistence. It was also verified that 13% of farmers cultivate between 2 and 3 ha of cassava, followed by 10% of farmers cultivating between 3 and 5 ha and only 6% farmers producing above 5 ha.

Table 2 – Total and average area of property and cassava crops dimensions (ha) in Campos dos Goytacazes-RJ (2016-17).

	Profile of crop dimension (2016/2017) – ha (%)							
Region	**Property Average Area (ha)**	**Up to 1**	**1 to 2**	**2 to 3**	**3 to 5**	**5 to 10**	**>10**	**Average Growing Area**
1	17.2	42.9	21.4	14.3	3,6	3.6	10.7	2.5
2	7.5	28.6	28.6	22.4	18,4	0.0	0.0	2.0
3	12.2	50.0	29.5	9.1	4,5	2.3	2.3	1.7
4	12.6	47.2	27.8	2.8	8.3	5.6	2.8	1.9
Total	11.7	41	27	13	10	3	3	2.0

Source: Author *or Field survey?.*

The research showed that the average of farms in the whole municipality was 2 ha, ranging between 1.7 ha (region 3) and 2.5 ha of cassava per property (region 1). This result reveals a small scale production and low income potential profile, which limits the accumulation of surplus and resources that could be destined to the use of new technologies.

Among the studied regions, region 1 stands out for an average area of 17.2 ha and the highest average area of cassava cultivation (2.5 ha), which points to possible relation between the area of property and production. Region 2, on the other hand, presented the lowest average area of ownership with 7.5 ha and a medium area of cassava cultivation of 2.0 ha, possibly attributed to the expressive number of land reform settlers. This context reveals a greater adaptability and a possible dependence on the crop, either as a source of income or subsistence, which limits the diversification of land use for other purposes.

Soil conservation

Soil conservation reflects producer perception about the use of recommended practices to preserve chemical, physical and biological characteristics of soil, aiming at the maintenance of productive potential of the area. There have been a significant number of producers which affirm to use conservation practices, but not always accompanied by technical assistance.

Table 3 presents 65% of producers asserting the use of conservation practices and 62.7% of this total report the use of organic fertilizer, followed by 29.4% crop rotation, 26.5% no-tillage and 2% crop intercropping.

According to Mattos (2000), intercropping crop is widely disseminated by small producers, aiming at the greater use of available area, besides being useful for soil conservation. In the region of Dourados (in the state of Mato Grosso do Sul), for example, 30% of cassava producers produce on intercropping crop system, commonly intercropping cassava with beans, rice, squash and maxixe.

According to Albuquerque *et al*., (2012), cassava crop contributes to the acceleration of soil losses due to erosion, owing to some characteristics of the plant and its cultivation, such as: slow initial growth, wide spacing between plants in the initial phase, soil movement in planting and harvesting.

In a study of Lima *et al.,* (2015), aiming to evaluate the development of agricultural practices under the cassava crop in the control of water erosion, they verified the application of mulching and intercropping were the most efficient practices in reduction of soil and water losses and could be used by farmers as a technique of soil and water conservation.

In despite of the great importance of cassava intercropping use, this practice is inexpressive in cassava fields in Campos-RJ, which may be related to the large number of depleted soils. According to Table 3, 28% of producers reported the existence of soil erosion, of which about 47.7% reported laminar erosion, followed by 38.6% furrow erosion and 13.6% of both types, all these problems contribute to low productivity of the region.

Combining the presence of erosion in the areas and the absence of conservation practices tends to exhaust soil and its fertility over time, gradually reducing crop productivity.

Table 3 – Soil conservation practices and erosion types in the properties (%) of Campos dos Goytacazes - RJ.

Soil conservation practice used by cassava producers

Region	Use of conservation practice (%)	Conservation practice used by producers (%)			
		Crop rotation	Organic fertilization	Intercropping	No-tillage

1	53.6	40.0	66.7	0.0	6.7
2	63.3	25.8	67.7	0.0	19.4
3	72.7	21.9	50.0	3.1	40.6
4	66.7	37.5	70.8	4.2	29.2
Total	65.0	29.4	62.7	2.0	26.5

Erosion existence and common types of erosion in properties				
Region	**Erosion existence (%)**	**Erosion type found due to erosion in properties (%)**		
		Laminar	**Furrow**	**Both**
1	50.0	21.4	64.3	14.3
2	20.4	70.0	30.0	0.0
3	34.1	46.7	33.3	20.0
4	13.9	80.0	0.0	20.0
Total	28.0	47.7	38.6	13.6

Source: Author.

Soil preparation and use of equipment and machines profile

Regarding the profile of using machines and equipment for soil preparation, the presence of animal traction was verified in this activity, although the great majority already makes use of mechanical traction. Table 4 shows that 86% of the producers use mechanical traction, while 18.5% use animal traces, which reveals they require a larger family workforce in these cases, limiting the production capacity of these producers.

Table 4 – Profile of using traction equipment (animal, vegetal and manual) of cassava producers in Campos dos Goytacazes-RJ

Profile of using animal, vegetal and manual traction equipment (%)			
Region	**Animal traction**	**Mechanical traction**	**Manual**
1	17.9	71.4	42.9
2	12.2	93.9	28.6
3	22.7	86.4	9.1
4	22.2	86.1	13.9
Total	18.5	86.0	22.3

Profile of equipment used by producers which utilize animal traction (%)			
Region	**Plow**	**Ox traction**	**Trimmer/Furrow**

1	100.0	0.0	0.0
2	50.0	0.0	0.0
3	50.0	10.0	10.0
4	87.5	0.0	25.0
Total	69.0	3.4	10.3

Profile of equipment used by producers which utilize mechanical traction (%)

Region	Plowing	Plowing + Harrowing	Harrowing
1	20.0	80.0	5.0
2	17.4	56.5	21.7
3	15.8	65.8	18.4
4	9.7	58.1	32.3
Total	15.6	63.0	20.7

Source: Author.

Among the producers using animal traction (18.5%), 69% use plow equipment and 10.3% use furrowers and manual trimmer (Table 4). This context may interfere on a larger need for labor power and a limitation of production. Regions 3 and 4 are highlighted among the areas with major use of animal traction, which suggests a greater limitation in soil preparation. The use of animal traction is very common in small areas, usually associated to manual preparation, in which are performed windrowing, plowing, harrowing and furrowing activities, mainly used by producers without capital (FIALHO, 2013). It is important to emphasize that the use of animal traction may be related to the impossibility of using mechanical traction, as occurs in sloping regions, proving to be a way of adapting farmers to limitations presented.

Among the producers using mechanical traction (86%), 63% of the producers use recommended plowing plus harrowing practices, while 20.7% only use harrowing and 15.6% plowing (Table 4).

However, it is important to highlight that machinery and equipment are crucial inputs that determine crops planting capacity. They act as entrance of production process and require investments, not always accessible to small producers, which was evidenced in the present study. According to Table 6, only 13% of producers have their own machinery and equipment, indicating more autonomy for planting and possibly lower cost of production, and inexpressive support from producer associations, with only 6% of producers having support of trade associations, increasing the low grade of organization of producers in regard to cover this need.

On the other hand, a high degree of dependence on third parties producers is indicated, being at the mercy of rent, contractors and eventually, depending on the municipal government. About 72% of producers rent machines and equipment for soil preparation, followed by 10% that depend on municipality government, totaling 82% of the producers. This reality tends to raise production costs, implicit risk and the degree of uncertainty in the activity, facing occasional adversities that inevitably compromise soil preparation, discourage planting and limit production capacity. In addition, producers who use the services offered by the municipal government are dependent on the availability of machines, which are not always accessible during planting or water period (Table 5).

Table 5 – Origin of machinery and equipment of cassava producers using mechanical traction in Campos dos Goytacazes-RJ (%)

Region	Producers using mechanical traction (%)	Own machinery/ equipment	Association	Leased/ Contractor	Municipal government	State Government	Other
1	71.4	25.0	0.0	70.0	0.0	0.0	0.0
2	93.9	8.7	0.0	87.0	4.0	0.0	2.0
3	86.4	5.3	21.0	61.0	8.0	0.0	5.0
4	86.1	22.6	0.0	65.0	26.0	0.0	3.0
Total	86.0	13.3	6.0	72.0	10.0	0.0	3.0

Source: Author.

Analyzing the areas, region 2 contrasts with 93.9% of producers who use mechanical traction, however, with a rate of 87% dependence on rent and contractors to prepare the soil. Regions 1 and 4, with more expressive number of producers with their own machinery, are also worthy of note. On the other hand, region 3 was characterized by only 5.3% of producers with their own machine, which presents high external dependence, such as 21% of producers use the machines and equipment of associations, which reveals the highest degree of organization considering the regions (Table 5).

Spacing and variety of cassava

Plants organization or arrangement in the area contributes in a determinant way to a greater or lesser competition among the plants due to competition of production factors (water, light and nutrients), affecting the productivity and land use.

A number of 80.3% of cassava producers analyzed reported using a spacing pattern, 26.2% of which use spacing mistakenly, either because of the high density or branches too spaced (Table 6). Considering Fialho and Vieira (2013), the most used recommendation is simple lines to improve results, corresponding to 1.0 to 1.2m among the lines and 0.60 to 1.0m among plants. Adding producers which do not use a spacing pattern to producers which use spacing mistakenly, the number extends to 40.8% of cassava production, demonstrating low levels of orientation and technological instruction of producers.

Table 6 – Spacing use and profile in cassava production in Campos dos Goytacazes-RJ (%)

Region	Spacing use		Sparse spacing	Recommended	+ spaced
	Does not use	Use	AL < 0.80 / AP < 0.80	AL = 1.0 – 1.2 / AP = 0.6 – 1.2	AL = > 1.3 / AP = > 1.3
1	21.4	78.6	18.2	81.8	0.0
2	20.4	79.6	10.3	74.4	15.4
3	22.7	77.3	20.6	73.5	5.9

4	13.9	86.1	16.1	67.7	16.1
Total	19.7	80.3	15.9	73.8	10.3

Source: Author. AL – Among lines; AP – Among plants.

It was also observed the use of several varieties in cassava cultivation, which are traditionally replicated among the producers, mainly passing on from generation to generation, without a proper concern about the origin and improvement of cultivars. There was also a great variation in productivity performance among varieties and few use of improved varieties. Table 7 shows the cultivation of 10 varieties, highlighting the use of “blacky” variety by 61.8% of the producers, followed by “purply” with 11.5% and “pinky” with 10.8%, “alagoana” with 9.6% and “Chilean bread” grown by 8.3% of producers.

Table 7 – Kinds of varieties used in cassava cultivation in Campos dos Goytacazes-RJ (%)

Region	Blacky	Purply	Pinky	Alagoana	Chilean bread
1	42.9	28.6	32.1	7.1	7.1
2	69.4	2.0	0.0	24.5	16.3
3	52.3	159	9.1	0.0	4.5
4	77.8	5.6	11.1	2.8	2.8
Total	61.8%	11.5	10.8	9.6	8.3

Region	Yellowy	“Santa cruz”	“Cachoeiro”	Cacao	Egg yolk
1	0.0	3.6	0.0	3.6	0.0
2	0.0	10.2	0.0	0.0	0.0
3	15.9	2.3	11.4	2.3	6.8
4	2.8	2.8	0.0	5.6	0.0
Total	5.1	5.1	3.2	2.5	1.9

Source: Author.

Among cultivated varieties, resistance and adaptation to edaphoclimatic adversities contrast, but with low cultivars productivity. It is also noted the low use of improved varieties, which could increase cassava productivity.

In regarding to origin of cassava branches, it occurs by the multiplication of the cultivation itself and also by other producers, which reinforces the replication pattern of these cultivars and its low performance. Cassava branch origin happens mainly by own producers (64.3%) and third parties (18.3%), usually associated with other producers (Table 8). There was no interaction between farmers and research centers that could recommend and supply improved cultivars, which could increase crop productivity.

Table 8 – Cassava branch origin e varieties cycle used in cassava production

	Cassava branch origin (%)			Varieties cycle used in cassava production (%)				
Region	Own origin	Third Party	Other	<8 months	8 to 10 months	10 to 12 months	12 to 14 months	> 14 months

1	71.4	25.0	0.0	3.6	17.9	53.6	7.1	0.0
2	59.2	20.4	0.0	10.2	32.7	26.5	6.1	4.1
3	54.5	13.6	0.0	9.1	27.3	11.4	13.6	6.8
4	77.8	16.7	2.8	8.3	52.8	25.0	0.0	0.0
Total	64.3	18.5	0.6	8.3	33.1	26.8	7.0	3.2

Source: Author.

Through analyzes of cassava production in Table 8, it is noticed the predominance of early varieties, in which 33.1% showed that production cycle varies between 8 and 10 months and 26.8% between 10 and 12 months. Only 10.2% of the producers showed cycles above 12 months.

Fertilization management

Low technological level used in cassava cultivation is indicated on the factor of inputs adoption, such as limestone, chemical or organic fertilizers. Analyzes present 63.1% of producers do not use limestone to correct soil “pH”, while 24.8% report to use it a few times (Table 9).

Fialho and Vieira (2013) observed that cassava usually has a tolerance to soil acidity, without noticing significant increase in production due to application of limestone. Nevertheless, they emphasize that frequent use of limestone in the same area produces very good responses from the plant to its application, especially by the nutritional increase of calcium and magnesium, which does not demonstrate to be the profile of producers interviewed.

Research conducted by Brancalião *et. al.* (2015) in Assis, state of São Paulo, show a direct relationship of liming with the highest initial growth and development of plant in response to limestone dosages. However, it indicates that plant development due to liming occurs up to dosage of 1,700 kg/ha, and that higher doses tend to reduce the number of stems per plant. Lorenzie and Dias (1993) corroborate that liming dosages must not exceed 2 tons./ha. Silva et al. (2013), when evaluating influence of dolomitic limestone (0 to 2000 kg/ha) together with phosphorus, verified increase in root weight in several cassava cultivars by adding macronutrients to the soil.

Fertilizer low use (NPK or other nutrients) corresponds to another agricultural practice that explains the decrease of cassava productivity in the municipality. This research indicates 74.5% of producers do not use fertilization, which is considered essential for plant nutrition and development and crop productivity. Among those who reported using it, 11.5% indicated that they use only a few times, not being usual fertilizers use in production (Table 9).

Fertilizers application in cassava cultivation proved to be another factor limiting the production. When analyzing different levels of macronutrient nitrogen (N), Oliveira et al. (2012) observed there is a direct relationship between applied dosages with root production and length. Experiments performed by Silva et. al. (2017) corroborate relation between macronutrient dosages with the increase of root diameter. The author highlights that the usage of tailor-made chemical fertilizers may increase cassava productivity gains, but considers that these inputs are not always available to farmers because of high prices or unavailability.

In this context, studies affirm although NPK dosage of 200 kg/ha had a cassava root productivity lower than 600 kg/ha dosage, from economic point of view, it was more endorsed due to minimum investment recommendations (ALVES et al., 2012).

When evaluating organic material utilization, it was examined that 40.1% did not use it and 24.8% showed eventual use in crops (Table 9). Nevertheless, limitations have been noted in the use under appropriate conditions to provide plant deficiencies.

Table 9 – Technological input adoption – limestone, defensive, chemical and organic fertilizers (%).

Region	Limestone utilization?			NPK utilization/Fertilizer			Organic material utilization?		
	Frequently	Sometimes	Does not use	Frequently	Sometimes	Does not use	Frequently	Sometimes	Does not use
1	17.9	32.1	50.0	10.7	10.7	78.6	39.3	21.4	39.3
2	6.1	26.5	67.3	14.3	14.3	69.4	24.5	26.5	49.0
3	9.1	25.0	65.9	4.5	9.1	86.4	36.4	22.7	40.9
4	16.7	16.7	63.9	22.2	11.1	63.9	41.7	27.8	27.8
Total	11.5	24.8	63.1	12.7	11.5	74.5	34.4	24.8	40.1

Source: Author.

Among these inputs, the most frequently used was organic material, usually more accessible and with low cost. Nevertheless, appropriated volumes to keep crops well fertilized, corresponding to plant nutritional needs must be questioned. When we evaluated other inputs, we highlight that fertilizers frequent use does not exceed 12.7% of producers, which reveals low technological level employed and explains low productivity (Table 9).

Cassava is a rustic crop and adapts well to low fertility soils, but exports large amounts of nutrients from the soil, and non-proportional replenishment tends to reduce nutrient reserves gradually, impoverishing and compromising crop productivity (FIALHO, 2013).

Pests and diseases management and control

This research presented low frequency of agrochemicals destined to pests and diseases management in crops, which demonstrates it as an indirect indicative of production loss. According to data, 66.9% of producers do not use any kind of agrochemical to control, followed by 26.8% of producers using it sometimes. 93.7% of producers become vulnerable and susceptible to pest and disease risk, as in case of caterpillar attack, which feed on leaves and substantially reduce the production (Table 10).

Sagrilo et. al. (2010) and Schimitt (2002) highlight that losses caused by the lack of control methods against pests and insects may reach 20 to 80% in productivity. According to Aguiar et. al. (2009), “mandarová-da-mandioca” (Erinnyis ello L.) is considered one of the most impacting pests in cassava in Brazil due to its high defoliation power.

Table 10 – Agrochemical utilization destined to pest and disease management (%)

Region	Agrochemical utilization profile		
	Frequently	Sometimes	Does not use
1	7.1	25.0	67.9

2	8.2	28.6	61.2
3	0.0	22.7	77.3
4	5.6	30.6	61.1
Total	5.1	26.8	66.9

Source: Author.

When analyzing pests and diseases occurrence, a possible relationship was found between low use of pesticides and the losses of production during production and harvest cycle. The study revealed that 54.8% of producers have pest and disease incidence, and 48.4% reported having production losses, evidencing a strong relation and impact on cassava production. Of this total, 38.2% of the losses occur during production cycle and 10.2% at harvest time. Only 7.6% of producers showed no losses attributed to pests and diseases. Among the major pests that affect cassava cultivation, the caterpillar has been the most frequent, affecting 48.4% of the crops, followed by 11.5% of other pests and diseases (Table 11).

Table 11 – Pests and diseases occurrence in crops, kind of production loss and major pests and diseases

Region	Pests and diseases occurrence (%)	Kind of production loss due to pests and diseases (%)			Major pests and diseases (loss) (%)	
		During production cycle	Harvest	No loss	Caterpillar	Other
1	67.9	46.4	21.4	7.1	57.1	10.7
2	55.1	32.7	12.2	8.2	53.1	8.2
3	50.0	34.1	4.5	11.4	40.9	22.7
4	50.0	44.4	5.6	2.8	44.4	2.8
Total	54.8	38.2	10.2	7.6	48.4	11.5

Source: Author. Data reflect kind of production loss percentage and major pests related to total number of producers.

In general, highlighted challenges seem to be attributed to low level of education and technical assistance. Furthermore, 93.7% of producers do not use any type of defense or use it eventually. Producers have not demonstrated systematic control of pests and diseases, which compromises crops production and profitability, limiting possibilities for accumulating resources to reinvest in property and technological inputs.

Fialho and Vieira (2013) assert cassava crop is tolerant of pest attack somehow, but they emphasize that production losses are accentuated when pests appear to a large extent, without proper control and under favorable environmental conditions, which seems to be the case of expressive incidence of *mandarová* caterpillar in crops (48%). This pest is notable for great defoliation capacity, which in severe cases may cause complete defoliation of the plant, reducing root production between 50 and 60%.

Control of invasive plants or weeds competing for light, water and nutrients with cassava plant were also analyzed in the first months after planting. According to Fialho and Vieira (2013), the degree of this competition determines damage intensity to the development and productivity, also depending on species and density of the type of forest established in the area.

In Table 12, which refers to this practice, it is illustrated 45.2% of cassava producers accomplish the control by weeding the area, 6.4% use chemicals and 8.3% use both.

Table 12 – Practices used to control invasive plants (%)

Region	Weeding	Chemical product	Both	Other
1	60.7	7.1	10.7	3.6
2	42.9	4.1	8.2	2.0
3	43.2	6.8	6.8	2.3
4	38.9	8.3	8.3	2.8
Total	45.2	6.4	8.3	2.5

Source: Author.

Also in reference to invasive plants control, 37.6% of producers do not perform this management, which possibly compromises their crops development and production. Fialho and Vieira (2013) highlight that cassava crop is sensitive to competition with weeds in the next months after planting, recommending plant development without weed competition between 90 and 150 days after planting.

Another aspect that was observed refers to the expressive use of weeding to control the competing plants (45.2% of producers). Although usually performed by the family itself, it is affordable and inexpensive, the workforce required is proportional to the size of the area, and requires a higher frequency of weeding for effective control of invasive plants. Considering the limitation of labor force and the demand for other agricultural activities, we can expect a low efficiency in weed control.

Carvalho (2000) affirms that competing weeds with cassava in early stages of crop development may significantly reduce crop production, especially in areas with little or no control.

CONCLUSION

This study presented a profile of cassava producers traditionally of small properties, corresponding to an average area of 11.7ha, and small scale of production, either as source of income and/or subsistence of the family. We evidenced low income potential and accumulation of surplus resources that could be reinvested in ownership and adoption of new technologies.

In general, there was a low level of technology and limited capacity to generate income in cassava production. Low level of soil conservation, the restriction of agricultural equipment, inexpressive and limited use of technological practices and management, improved varieties, soil analysis, technological inputs (limestone, chemical fertilizers, organic and defensive fertilizers) and inefficiency in the control of pests and diseases.

This context reveals low degree of modernization of cassava in the municipality of Campos-RJ, intensive and extractive land use, usually produced on a small scale and with low level of capitalization and productivity of labor and also of the land. These factors seem to stimulate a vicious cycle, with poor crop performance and profitability, low capacity for accumulation of resources, capital and technological possibilities, favoring a gradual process of discouraging production. Without the possibility of gains and accumulation of income, the degree of uncertainty and risk tends to increase as adversities and external forces turn permanence and perpetuation of the activity even more difficult, highlighting the climatic factors and commercialization obstacles and price oscillation in the market.

ACKNOWLEDGEMENTS

We thank the State University of Northern Fluminense (UENF) and the Foundation of Research Support of the State of Rio de Janeiro (FAPERJ) for the encouragement of the doctorate degree. We would also like to thank the Phytotechnology Laboratory, and the doctor Silvio Freitas for all instructions, advices, confidence and autonomy, and to university graduate students who, without the contribution of each one of them, this research could not possible to be done. And especially to the partners as the Municipal Agriculture Secretary, the local office of EMATER-Rio, leaders of producers, presidents of agricultural associations and farmers who trusted us their attention for this research.

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