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Full Length Research Paper

Characterization of rice production system in Camacupa and Catabola municipalities of the province of Bié in Angola

Chiambo, P. J.[1]*, Coelho, J. P.[2], Soares, F. B.[3] and Salumbo, A.[4]

[1]Tropical Knowledge and Management Program, Universidade Nova de Lisboa-NOVA School of Business and Economics, Portugal.
[2]School of Agriculture, University of Lisbon, Portugal.
[3]Nova School of Business and Economics, New University of Lisbon, Portugal.
[4]University José Eduardo dos Santos, Huambo, Angola.
*Corresponding Author E-mail: paschiambo81@gmail.com

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An assessment of rice production and processing in Camacupa and Catabola municipalities of the province of Bié in Angola was carried out in this research. According to the results obtained the planting period for rice in the area was mostly between October and November. Basically 100% of the farmers do the rice seeding directly to the permanent place where it germinates and grows to maturity. Results revealed that 61% of farmers in those two municipalities use manual labor in seedbed preparation, while 49% use tractors but complemented with manual instruments. It was also observed from the results that the farmers in the study area predominantly used 12-24-12 (N-P-K) and ammonium sulfate (NH_4SO_2). The application method was mostly by manual broadcasting over the planted area. Results also recorded that rice harvesting usually takes place from May to June. All the farmers interviewed harvest their rice manually by using knife and sickle, and they thresh the harvested rice manually by spreading rice on canvas and tapping with a stick. The paddy yield varied from 200-1800 kg.ha^{-1} depending upon the availability of resources, management of crop and the socio-economic status of the growers. The paddy resulted is packed in a bag, mainly, or in bottle if it is destined to seed. Results also showed that mechanization of rice production and processing has not received much attention since most of the farmers still use the traditional manual labor and traditional in the production and processing rice. The study also found that rice productivity is positively correlated with the level of education, the tractor usage, the rate of application of fertilizers, the sowing date (the later the better, the line coverage, the place of sale (in markets is better) and the processing methods (mechanized is better). On other hand, productivity is negatively correlated with the municipality (Catabola is better), the village (Ndembei, Kalila and Kalohuma, are better) and the age of the farmers (i.e. the younger the greater workforce and higher productivity).

Keywords: Rice production and processing, Angola, province of Bié, traditional and business sectors

INTRODUCTION

Rice production systems vary greatly from country to country as well as from location to location which affects the performance and the potential of its production. Rice is cultivated under temperate, subtropical, and tropical climatic conditions with the weather varying from arid and semiarid to sub humid and humid (Rao *et al.,* 2017; Okeke and Oluka, 2017). The cultivation of rice begins by land preparation in order to prepare the seedbed, which could include land clearing, construction of dikes, soil tillage, ploughing and leveling with the aid of earth-moving equipment, depending on the size farm (Ayanda and Folounsho, 2019). After land preparation, planting begins by planting either water soaked rice or dry rice seeds. Seeds can be sown either manually (in small farms) or mechanically (in large farms), but in developed countries low flying planes broadcast rice seeds onto already prepared fields. If rice is not planted directly to the field, after one month or less of growth, the seedlings are transplanted in bunches from nursery beds to main field. First weeding is done 1 month after transplanting or 21 days after germination for those planted directly to the field. Second weeding is generally done 36 days after first weeding (Okeke and Oluka, 2017). According to Corranza and Treakle, (2014) and Carriço, (2017), 60% of African farmers use manual labor since sowing to processing.

Threshing of rice follows the harvesting operation and in a full-mechanized system, harvesting and threshing are done simultaneously with combined harvester. After harvesting, rice is threshed manually or mechanically and it is packed in bags of 10, 25 or 50 kg. Before milling, rice grain is dried in order to reduce the moisture content to about 19% to avoid breakage of seeds during milling. The drying can be done naturally by sunshine spreading the rice on the tarpaulin (developing countries), or by drying machines through artificially heated air (developed countries). After rice is processed at a mill using automated processes, the paddy rice undergoes many processes like hulling, polishing, grading, destoning, etc., before marketing or storage (Okeke and Oluka, 2017). The production and processing of rice in Central Plateau of Angola is mostly done by traditional or mechanized methods. Studies made by Chiambo *et al*. (2019) showed that there are two types of rice production systems, namely the permanent flooding system, which is greatly practiced by the business sector, and the rain-fed system, practiced by the traditional sector. The high level of food imports in the country demand adequate attention and assistance to the family farming and processors of agricultural food materials. Various agricultural wastes, such as rice straw, are being used for animal feed and manure. After maize and cassava, rice is one of the most valuable food staples for a large share of Angolan population (Chiambo *et al*., 2019). However, mechanization of its production and processing in many rural areas has not received much attention making production, processing and even storage difficult for the farmers.

The main issue of rice production in Central Plateau of Angola is that farmers face difficulties in its production and processing because of their poor knowledge of newer methods of land preparation such as tillage, seed planting or sowing, fertilizer application, weed and pest control methods, harvesting, threshing, processing and storage of the farm product (Chiambo *et al*., 2019).

Agronomic practice is the key issue that play crucial role for increasing crop productivity. However, we do not find any study to deal with farmers' practice, productivity of rice crops and representation of women in agricultural in particular in the Bié region. Thus, the present study was undertaken to generate valuable information regarding agronomic practice, performance of rice cultivation in different seasons and roles of women in households in Camacupa and Catabola municipalities. Therefore, the aim of this research is to obtain data on rice production and processing in Central Plateau of Angola, which will guide the government, the agricultural policy makers, the students and the researchers in devising measures for improving/ or mechanizing rice production and processing in the area. The specific objectives of the study were as follows:

(a) Describe rice cropping systems, status of varietal adoptions, farmers' crop management practice and level of access to extension services.
(b) Assess the profitability of rice grown in the different seasons.
(c) Evaluate roles of women in farming and other decision-making process.

MATERIALS AND METHODS

Study area

The province of Bié has been purposely chosen for the reason that rice is historically cultivated in the region where its inhabitants cultivate rice by habit and/or tradition using rudimentary exploitation techniques. Rice cultivation in the province of Bié focuses mainly on river basins, wetland areas and highlands areas in the rainy season, involving poorly drained and periodically flooded explanations. Uncontrolled flooding or flooding rice are produced with the highest specific incidence in the municipalities of Camacupa and Catabola (Diniz, 1998). Our study is directed at these two municipalities of the province of Bié (Figure 1). Camacupa is a municipality of the province of Bié in Angola, located north of the capital city Cuito and represents the geodesic center of Angola. It has 9,469 km^2 and about 289 thousand inhabitants. It is bordered to the north by the municipalities of Nharea and Luquembe, to the east by the municipalities of Cuemba, Moxico and Lucha, to the south by the municipality of Chitembo and to the west by the municipalities of Catabola and Cuito. Catabola is a town and municipality in Bié Province in central Angola which is located 52.5 kilometers northeast of Cuito, and 15 kilometers on the road to Camacupa and Catabola municipalities were purposely selected for this study based on their agronomic suitability and tradition of growing rice (Diniz, 1988; Chiambo *et al*., 2019).

Methods

The study of the traditional rice sector included the collection of primary data through a semi-structured questionnaire and secondary data from published and unpublished reports. The objective of the study was clearly explained to farmers for developing rapport with the villages to generate reliable data. The field survey was conducted covering all major rice-growing ecosystems

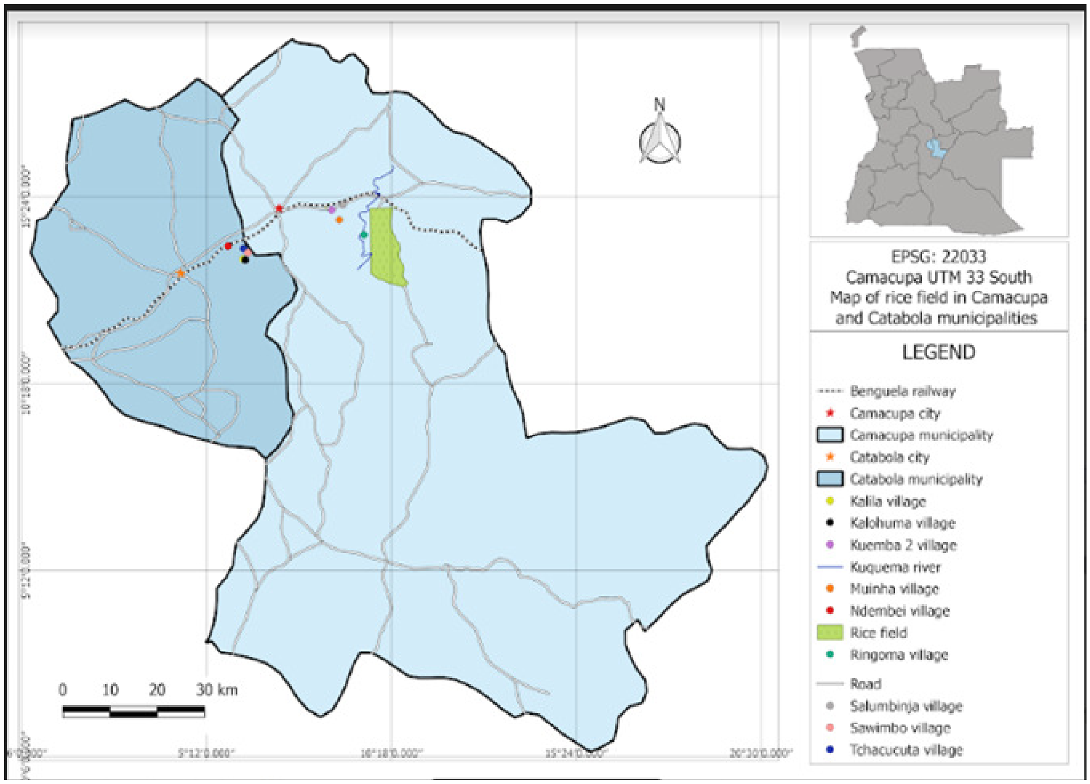

Figure 1. Camacupa and Catabola municipalities

of Camacupa and Catabola municipalities to understand the cultural practices used by farmers, production constraints, type of variety of seed used and mode of implementation in the field. The socio-economic profile, land ownership, rice management practices, biotic and abiotic stresses that limit rice productivity, harvest and post-harvest management practices and farmers perception on rice cultivation technology were also observed. Six villages out of 41 of Camacupa and five villages out of 35 of Catabola municipalities covering all major rice-growing eco-systems were random selected. Catabola and Camacupa have a total of 514,000 inhabitants spread over 76 villages of which 1.903 are farmers involved in various agricultural activities (RGPH, 2014). The sample was chosen at random from rice farmers covering 14.4% of villages (11) and 5.7% of farmers (110).The survey were done from June to October. Each farmer was individually surveyed in his/her own language while working in the field to ensure the reliability of their claims. Male respondents were asked about role of women in household and agricultural activities and participation of women in decision-making process.

The total land area owned by farmers surveyed in both municipalities was about 15 ha. All the 110 farmers surveyed practiced dry seeding in rain-fed conditions. In order to understand the functioning of the rice value chain (rice row) in the business sector, a unique interview was done to the head of Farm Arrozeira Society of Camacupa. In addition, the rice production system adopted in major irrigation and rain-fed rice ecosystems were also characterized. The data collected were cleaned before entering into computer and after they were treated and analyzed by using the statistical program *Statistica 10* version. The treatment of data involved Descriptive Statistics (expressed using numerical frequencies and percentages presented in descriptive statistical tables and figures), Analysis of Variance and comparison of means and multi regression methods.

RESULTS AND DISCUSSION

Social characteristics of the farmers

Table 1 presents the data of some of the social characteristics (Age, Marital status and Gender) of the 110 rice producers of the sample. In terms of age, the results showed that 35.45% of the respondents and rice producers are in the age group of 40-50, with a global age mean of 48.92 years. About 58% of the respondents are less than 50. Concerning the marital status, most of the respondents are single 75.5% (83). This means that middle age farmers mostly practice rice farming. This finding is consistent with the findings of Faust and Christopher, (2015) who report that the mean age of rice farmers in their study was 49 years. This is only natural since the middle age classes, who are physically fit to

Table 1. Social characteristics of the farmers (Age, Marital status and Gender).

Age				Marital status (Ms)			Gender (G)		
Years	**Freq**	**%**	**Average (years)**	**Ms**	**Freq**	**%**	G	**Freq**	**%**
20-30	6	5.45		Single	83	75.5	Male	74	67.27
30-40	19	17.27		Married	17	15.45	Female	36	32.73
40-50	39	3545		Widow	10	9.09			
50-60	35	31.82	48.92						
60-70	5	4.55							
70-80	6	5.45							
Total	110	100			110	100		110	100

Source: Field Survey, 2018.

Table 2. Social and economic characteristic of the farmers (Years of education, Household number and Plot size).

Years of education			Household number			Plot size (sq. meters)		
Years	**Freq.**	**%**	**Number**	**Freq.**	**%**	**Size**	**Freq.**	**%**
0	23	20.91	1	4	3.64	0.00< x ≤ 5.000	108	98.18
1	41	37.27	2	14	12.73	5.000< x ≤ 10.000	1	0.91
2	20	18.18	3	16	14.55	10.000< x ≤ 15.000	0	0.00
3	15	13.64	4	23	20.91	15.000< x ≤ 20.000	1	0.91
4	6	5.45	5	17	15.45			
5	2	1.82	6	9	8.18			
6	2	1.82	7	9	8.18			
9	1	0.91	9	10	9.09			
10	0	0.00	10	8	7.27			
Total	110	100	Total	110	100	Total	110	100

Source: Field Survey, 2018.

withstand the stress and risks involved in rice production, and are more mentally alert to embrace new techniques of production. In addition, male farmers that represent 67.27% of sampled farmers dominate rice production in the study area. This is in contrast with Ibitoye *et al.* (2012) who found out that there were more female rice farmers than males in their study area.

Table 2 presents the data of social and economic characteristics of the sampled rice producer's farmers (Years of education, Household number and Plot size). Theoretically, the level of education will favor the adoption of new technologies. Unfortunately, in our sample, 10% of the farmers have more than 4 years of education. Concerning the Household number, most of the respondents have less than 5 people (74; 67, 27%). Lastly, the results showed that farmers in the study area are very small scale farmers (the mean plot size is 1360. 52 square meters, and 98.18% (108) of it are lower than 0.5 hectare) what makes mechanization difficult. This translates into the bulk of rice production for subsistence needs leaving little space for commercial purposes. Also, Ibitoye *et al.* (2012) and Faust and Christopher, (2015) confirmed that (53.00%) of rice farmers in their studies areas cultivated between 1-3 hectares.

Rice farmers experience, reason for growing rice and land tenure system

Table 3 shows that rice farming is practiced amongst farmers in the study area (40.3% with less than 5 years of experience), the average being 10.75 years. Table 3 also explains the various reasons that have motivated farmers to engage on rice production. The main emphasis is that 80% (88) cultivate for reasons of habits or tradition of the village, while the minority does it for reasons of food taste 19% (21) and 0.9% (1) does it for test or pleasure. Concerning the land tenure regime, about 33.7% (37) are the owners of their plots, 21.7% (24) cultivate it under occupation, 20.4% (22) has been ceded to them by the interest showed in production. 17.1% (19) cultivates lands inherited from their ancestors, and 7.1% (8) own the land for usufruct, being this last a land tenure regime that imposes restrictions on long-term investments and loans.

Crop management practices

Equipment's usage

The entire population sampled in the two municipalities uses manual instruments in all cultural operations, from soil preparation to processing. In our sample, 100% (110) use the hoe to prepare the soil, 11.8% (13) use rake for soil leveling, 50% uses machetes to cut trees, 70.9% (78) use knives and 29.1% (32) used sickles for harvesting. Only 44.5% (49) of the farmers use a tractor at the first plowing complementing the hoe, and a minority of 2.7%

Table 3. Rice farmers' experience, reason for growing rice and land tenure system.

Experience in Rice farming				Rice growing			Land tenure system		
Years	Freq.	%	Average (years)	Reason	Freq.	%	Tenure	Freq.	%
0< x ≤ 5	44	40.3		Tradition	88	80.01	Proper	37	33.7
5< x ≤ 10	26	23.7		Taste	21	19.09	Occupied	24	21.7
10< x ≤ 15	16	14.4		Test/Pleasure	1	0.90	Ceded	22	20.4
15< x ≤ 20	12	10.9					Heritage	19	17.1
20< x ≤ 25	3	2.58	10.75				Usufruct	8	7.1
25< x ≤ 30	7	6.3							
30< x ≤ 35	1	0.91							
35< x ≤ 40	1	0.91							
Total	110	100			110	100	-	110	100

Source: Field Survey, 2018.

Table 4. Equipments usage in rice production.

Category	No	Yes	% age
Hoe	0	110	100.0
Rake	97	13	11.8
Machetes	55	55	50.0
Sickle	78	32	29.1
Knife	32	78	70.9
Tractor	61	49	44.5
Animal traction	107	3	2.7

Source: Field Survey, 2018.

(3) uses animal traction as shown in (Table 4). Work from land preparation to processing, relies mainly on the family's workforce. The lack of capital to finance the processing of rice prevents farmers to embrace rice production. Instead they pay more attention to the production of beans, corn and vegetables, since these crops provide the income to supply the needs of their families. The type of instruments and equipment, presented above, is an important indicator to measure the level of technological development of the agricultural producers surveyed. For now, the hoe, the machete and the knife are, so to speak, the visible face of the technology used the producers under study. It is still a rudimentary technology, although the use of mechanical traction is the only element that introduces a technological differentiation between cultivation practices.

Soil preparation, sowing and harvesting methods and time of crops

The research showed that the population of the sample was very heterogeneous in relation to the soil preparation. Since the production system is rain fed, usually the soil preparation is done three months before sowing, beginning in July or August. In most cases, soil preparation begins with clearing the soil, joining and burning the grass, harnessing and spreading the ash over the ground. Figures in (Table 5) show that 70% of farmers prepare the soil in August 85 (77.2%) do the sowing in November and 69 (62.2%) harvest in June. While 30% prepare the soil in July, sow in October and harvest in May. It is clear, from the survey that the land preparation practices adopted by farmers depend on their financial situation, plot size, soil nature and previous crop.

Besides, tractor is unable to reach in the corner of the small plots so that farmers used spade for manually pulverize which increase labor cost. When farmers use tractors for tillage, usually two passes are given by tractor for pulverizing the soil. Farmers mentioned that two passes by tractor is adequate for making a good soil bed. The high rental charge of tractor represents an effective restriction for its adoption by many farmers. Results also show that in all the sampled population in the studying area the rice is sowed directly at the definitive location, and the transplant method is not used, because it is rather laborious and does not compensate. Thus, approximately 56% of the farmers in the sampled area do direct sowing broadcasting and 44% do the direct sowing in line as shown in (Table 6). Table 6 also shows the land preparation and planting method used by rice farmers in the study area.

Rice varieties under cultivation

Table 7 illustrates the adoption rates for major rice varieties in the 11 villages. *Carolino* and *Kessongo* were the major cultivars adopted by respectively about 53.6% and 23.6% of the farmers. *Cahilahila* and *Silewa* were adopted by respectively about 14.5% and 8.1% of the farmers. The main motivations for adoption of different

Table 5. Soil preparation, sowing and harvest month.

Soil preparation month	Freq	%	Sowing month	Freq	%	Harvest month	Freq	%
July	34	30	October	25	22.7	May	41	37.2
August	76	70	November	85	77.2	June	69	62.7

Source: Field Survey, 2018.

Table 6. Methods of land preparation and planting rice.

System of propagation			Land preparation		Planting method	
Transplanting (%)	Direct Seed on line (%)	Direct Seed broadcasting (%)	Manual (%)	Mechanical (%)	Manual (%)	Mechanical (%)
0	44.0	56.0	55.5	44.5	100	0

Source: Field Survey, 2018.

Table 7. Seed varieties, sources and selection criteria.

Seed varieties			Seed sources			Selection criteria		
Varieties	Freq	%	Sources	Freq	%	Criteria	Freq	%
Kessongo	26	23.6	self-produced, local market or neighboring farmers	90	82.0	Yield	34	30.9
Carolino	59	53.6				Regularity	9	8.1
Cahilahila	16	14.5	official Agriculture Department	20	28.0	Flavor	40	36.3
Silewa	9	8.1				Resistance	27	24.5
Total	110	100	-	110	100	-	110	100

Source: Field Survey, 2018.

varieties included, higher grain and straw yield, yield regularity, organoleptic properties and higher resistance to lodging and diseases. Good quality seed is the main key component of crop production. Out of the 110 farmers interviewed, 82% acquire self-produced seeds, in the local market or neighboring farmers; the other 28% (20) get it from the official Agriculture Department. Baloch *et al.* (2004), doing a similar study, also founded that there was high dependence on self-produced seeds which were not cleaned, stored and processed according to standard procedures. The seed rate was found to be uniform (80 $kg.ha^{-1}$) and higher than that for official Agriculture Department recommendation (65 $kg.ha^{-1}$). It may be because of farmers have lack of knowledge on seed rates and germination rates of household seed is low.

Pest, diseases and weed control

The enemies of the crop are related to the presence of weeds, pests and diseases. Weed flora varies from place depending on the type of soil and the cultural practices. Weeds are the most important biological constraint because they emerge simultaneously with rice seedlings. Weed control is not made by 54.5% of farmers in Camacupa municipality this is due to the method of rice seeding in the field (direct broadcasting). For those who make manual weed control, 39% of farmers perform only one intervention and 6.3% only two (Table 8); the average number of controls was bigger in the municipality of Catabola. All farmers in the sample reported that the most frequent diseases affecting rice are Brown rot sheath (*Pseudomonas fuscovaginae*) and Brown spot (*Cochliobolus myabeanus*). The most frequent pests are rice grasshopper, rice beetle, "saliva animal", birds, hippopotamus and rabbits. The control of pests and diseases is similar to that of weeds; only 45,5% of the farmers control rabbits attacks through the use of traps. Farmers do not make any control for the rest of the plagues.

Fertilizers usage, origin and transportation

Availability and application of organic fertilizer has been decreasing overtime due to the reduction of the cattle number per household in the villages. Therefore, today, farmers are fully dependent on chemical fertilizer for cropping, and the rate of application of the fertilizer has been increasing. Farmers apply fertilizers into two different top dresses. First top dress includes 12-24-12 (NPK), and second top dress included ammonium sulfate (NH_4SO_2). Just a small number of all farmers interviewed were aware of and applied the recommended dose of

Table 8. Crop Control and number of controls.

Culture control enemy			Number of controls		
Category	**Freq**	**%**	**Category**	**Freq**	**%**
No control	60	54.5	0	60	54.5
Manual	50	45.5	1	43	39.0
Chemical	0	0.0	2	7	6.3
Total	110	110	-	110	100

Source: Field Survey, 2018.

Table 9. Fertilizer rate application.

Rate (kg ha^{-1})	Sulfate Ammonium			
	Freq	**%**	**Freq**	**%**
0.00	60	54.55	61	55.45
$0< x \leq 50$	1	0.91	1	0.91
$50< x \leq 100$	7	6.36	12	10.91
$100< x \leq 150$	3	2.73	23	20.91
$150< x \leq 200$	27	24.55	10	9.09
$200< x \leq 250$	7	6.36	2	1.82
$250< x \leq 300$	1	0.91	0	0.00
$300< x \leq 350$	4	3.64	1	0.91
Total	110	100.00	110	100.00

Source: Field Survey, 2018.

Table 10. Source and means of transportation of the fertilizer.

Source of the fertilizer	Freq	%	Means of transportation	Freq	%
Formal/Informal Markets	18	16.36	Car	35	31.82
Official Services	32	29.09	Hand	5	3.64
None	60	54.55	Hand car	2	1.82
			Motor taxi	8	7.27
			Missing	60	54.55

fertilizers. However, the dose of fertilizers varied from 0-350 kg.ha^{-1} in case of 12-24-12 (NPK), and the same amount in case of ammonium sulfate. About 55% of them did not use apply any type of fertilizer and 45% used between 50 and 317 kg ha^{-1} of dose 12-24-12 (NPK), and ammonium sulfate (NH_4SO_2) (Table 9). On average, farmers applied 84 kg.ha^{-1} of 12-24-12 and 60 kg.ha^{-1} of ammonium sulfate. Research has shown that fertilizers are purchased in the formal or informal markets or in the services of the Department of Agriculture (Table 10). From the farmers acquiring fertilizers 16% bought it in the formal/informal markets and 29% in the Department of Agriculture. From purchase to destination, the fertilizer was transported by car (31.8%), hand (3.6%), hand car (1.82%), motor taxi (7.27%) or unknown means (54.55%).

Harvesting and threshing

Rice in Catabola and Camacupa is mainly harvested and threshed manually. Harvesting is done in May and June when the whole plant has a yellow color and 5 to 10 percent of grains are dry, upon a tooth test to determine the moisture content. Another important determinant factor for the time harvest is the frequent presence of birds on the panicle and the panicle inclination. About 58% of harvest and 93% of threshing is made by M/W[1], followed by 38% of the harvest made by M/W/C[2] and 4 % of threshing made by M/C[3] (Table 11). In harvesting

[1] M/W-men and women
[2] M/W/C-men, woman and child
[3] M/C-men and child

Table 11. Harvest and threshing acts.

Category	Harvest act		Threshing act	
	Freq	%	Freq	%
M/W	64	58.18	102	92.73
M/C	4	3.64	4	3.64
M/W/C	42	38.10	3	2.73
W		0,00	1	0.91

Source: Field Survey, 2018.

Table 12. Processing and storage acts.

Category	Processing act		Category	Storage act	
	Freq	%		Freq	%
M/W	92	83.64	bags	93	84.55
M/C	2	1.82	bottle	11	10.00
M/W/C	5	4.55	Mat container	6	5.45
W	11	10.00			

Source: Field Survey, 2018.

activity about 70.9% use knives and 29.1% use sickle (Table 4). Male and female farmers then carry harvested paddy to a threshing floor that was previously prepared by removing weeds, sand and other debris. The threshing is done slowly to avoid breaking the rice grains using traditional harvesters. Then using a special wood stick, seed are separated from straw in a very labor and time-consuming process. On average to thresh 1 hectare of paddy field requires 13–15 person-days of about 12 h. With this method the seed breakages and the contamination with sand is high. According to Weerakoon *et al.* (2011) this method of threshing is now seldom practiced and trampling rice using a 4-wheel tractor or mechanical thresher is now the common method. As the labor requirement for harvesting and threshing is high, mechanization is essential for a sustainable rice production.

Processing and storage

About 86.3% of the rice produced is processed manually using traditional mill or mortars. The remaining 13.6% of the farmers that use the husks available in the Department of Agriculture[4],that has a small processing capacity of 500kg.h^{-1}. The artisanal processing results in grains of poor quality, less attractive to the consumer, which then prefers the imported rice. About 84% of processing is made by M/W[5], and about 85% of storage is made in bags (Table 12).

Yields (paddy rice)

The paddy yield varied from 200 to 1800 kg.ha^{-1} depending upon the availability of resources crop management and the socio-economic status of the growers (Table 13). Table 13 shows 40.91% registered a yield from 600 to 800 kg.ha^{-1}; 21.82% registered a yield from 800 to 1000 kg.ha^{-1} and only 1.82% of the famers reached yields from 1600 to 1800 kg.ha^{-1}. On average, the total yield was 894.38 kg.ha^{-1} (with a minimum of 359.71 kg.ha^{-1}; and a maximum of 1800,00 kg.ha^{-1}.

Differences between the two municipalities

Table 14 gives a statistical description of the means of several variables that allow determining the difference between the rice producers of the two municipalities. According to the Table 14, the significantly differences observed between the two municipalities are:, the age of the farmers, the level of education, the number of households, the time devoted to agricultural work, the productivity achieved, the application rates of fertilizers and the number of controls of crop enemies. Catabola, compared to Camacupa, has a younger population, a higher average level of education, a higher household number, slightly more years of rice cultivation experience, higher application rates of fertilizers, more control number of crop enemies and, consequently, a higher rice productivity.

Productivity and correlated and explanatory main variables

In order to establish the relationships between the different variables and the productivity, we have explored

[4] There are only two processing machines located one in the department of the agriculture of the municipality of Catabola and another in the municipality of Camacupa.
[5] M/W-men and women

Table 13. Paddy yield.

Yield kg/ha	Freq	%
200< x ≤ 400	2	1.82
400< x ≤ 600	6	5.45
600< x ≤ 800	45	40.91
800< x ≤ 1000	24	21.82
1000< x ≤ 1200	18	16.36
1200< x ≤ 1400	7	6.36
1400< x ≤ 1600	6	5.45
1600< x ≤ 1800	2	1.82

Source: Field Survey, 2018.

Table 14. Catabola and Camacupa means for several socio-economic variables (*).

Municipality	Age*	Years of education*	Household number*	% of agricultural labor*	Rice cultivation experience	Productivity (kg. ha^{-1})*	Application rate of fertilizer 12-24-12 (kg. ha^{-1})*	Number of controls*	Application rate of fertilizer ammonium sulfate (kg. ha^{-1})*
Catabola	44.64	2.08 a	4.50	0.91	11.38	1076.21	163.71	0.90	117.36
Camacupa	52.48	1.28 b	6.85	0.97	10.23	742.85	17.48	0.20	11.38

Source: Field Survey, 2018.* variable means of the two municipalities are significantly different by F test (N=110; df: 108; p<0,05)

the data through a correlation analysis. Table 15, synthetizes the statistical significant correlations (positive or negative) that we have found. From the Table 15, we can deduce that rice productivity is positively correlated with the level of education (i.e., the higher the level of education, the greater the capacity for technological perception and adoption), the tractor usage (that accelerates fieldwork and allows to extend the fields cultivation), the rate of application of fertilizers; the sowing date (the later the better), the line coverage (i.e., involving all the family work force - M/W/C - is better), the place of sale (in markets is better) and processing methods (mechanized is better). On the other hand, productivity is negatively correlated with the municipality (Catabola is better), the village (Ndembei, Kalila and Kalohuma, are better) and the age of the farmers (i.e. the younger the greater workforce and higher productivity). Finally, we have tested a step-by-step forward multiple regression analysis to identify the variables with the greatest explanatory power on final productivity achieved by the producers (Table16). From Table 16 we can conclude that the final production achieved can be essentially explained by four variables: Number of controls (with an explanatory power of 43%); Age of producers (with an extra explanatory power of 2.5%), Processing method (with an extra explanatory power of 6.5%) and sowing month (with an extra explanatory power of 3.8%). Those four variables have a total explanatory power of the productivity achieved by the farmers of 55.8%.

Gender and labor questions[6]

Men and women have different responsibilities in rice production systems. In the sampled area of this study, it was observed that women constitute bulk rice farmers. However, women have a major participation in various specific tasks of the cultivation of rice, such as transplanting/sowing (34 W; 69 M/W) weeding (11 W; 42 M/W), harvesting (64 M/W; 42 M/W/C), threshing (101 M/W; 1 W; 3 M/W/C) or processing (92 M/W; 11 W; 5 M/W/C). These differences in gender roles are not always obvious, but they must be recognized if rice production is to be increased, especially among the small-scale farmers. From Table 17 it seems that it is the man's specific tasks cutting trees (107) and opening the grooves (49). In majority of cases men only help women in tillage, weeding and ground cover, harvesting, threshing and processing things that are traditionally the domain of women. Sometimes they also involved children, in several field activities namely in bird and rabbits control. The gender roles and responsibilities, indicate how much time different household members devote to different tasks (and why) and shows how these tasks change according to the season and time of the day. The survey revealed that participation of women in

[6] The categories that we have considered are: M – man; W – woman; C – children, and the combination of those three (M/W; M/C; W/C; M/W/C).

Table 15. Significant Correlations between variables and productivity (p<0.05).

Variable	Productivity
Municipality	-0.529630
Village	-0.329861
Age	-0.279742
Years of education	0.204840
Tractor usage	0.493386
Rate of application of fertilizer 12-24-12 (kg/ha)	0.557567
Rate of application of fertilizer ammonium sulfate (kg/ha)	0,575979
Total fertilization cost (kg/ha)	0.589286
Sowing month	0.204935
Ground cover	0.305833
Place of sale	0.335937
Processing methods	0.317724

Source: Field Survey, 2018.

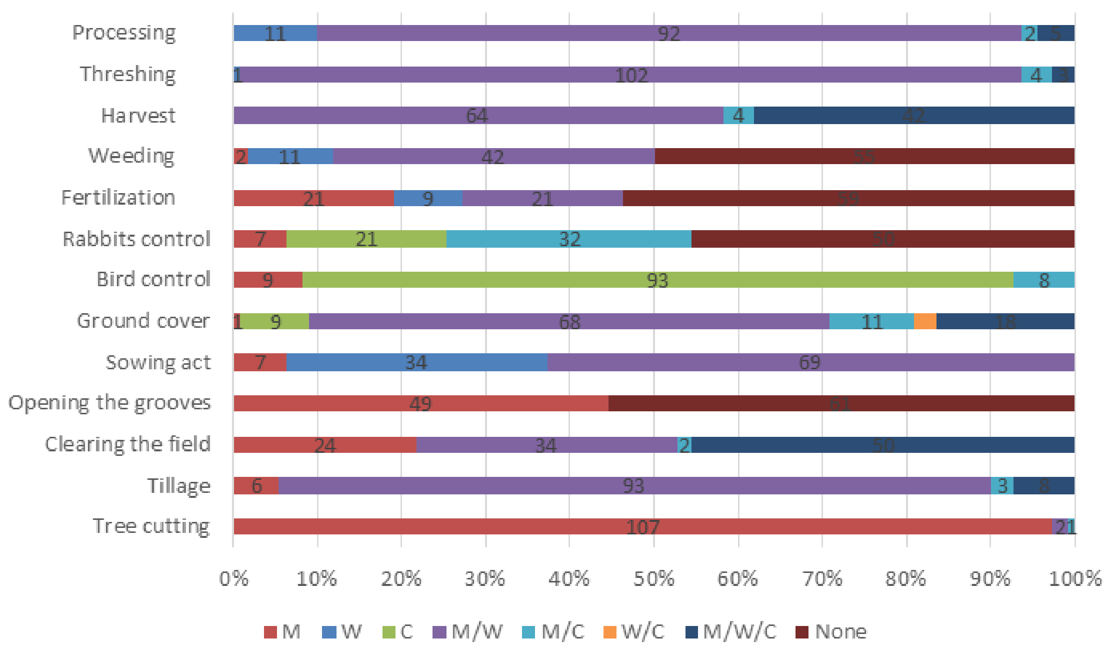

Figure 2. Labors and Gender usage.Source: Field Survey, 2018.

the intercultural activities (e.g., tree cutting, opening grooves, and birds and rabbits control) is scarce. However, Figure 2 shows that the participation of male, female and children in farming reveals the strong importance of the women in the crop system (Figure 2). Women's contributions in decision making about farming in particular selection of crops and crops cultivars to be grown in sowing, planting and harvesting dates as well as in hiring and selling labor is also negligible. However, women had equal roles as their male counterpart in decision making on buying and selling of property and livestock, the same occurring in the participation in borrowing groups and deciding marriage of children.

Characterization of the farm "Arrozeira Society of Camacupa"

The farm is located in the southeast of the Camacupa Municipality and it is irrigated from the Kuquema River. The farm, with a total area of 500 hectares, has a road network system, an irrigation system, with two pumping stations with six turbines, each turbines pumps 300 $l.s^{-1}$ of water, a drainage system and irrigation ditches. The sizes of the beds vary according to the topography of the land. In the areas with regular geometry beds dimensions vary from 34-38 hectares, and in irregular geometry areas beds dimensions vary from 4-9 hectares.

Table 16. Regression Summary for Dependent Variable: Productivity (kg/ha) (Adjusted R^2= 0.61; F (5.95) =26.558; p<0; Std. Error of estimate: 199.25).

	b*	Std. Err.	b	Std. Err.	T (95)	p-value
Intercept			-25844.487	10,449.469	-2.473	0.015
First variable to enter: Number of controls	0.506	0.082	244.127	39.678	6.153	0.000
Second variable to enter: Age	-0.186	0.073	-5.125	2.026	-2.529	0.013
Third variable to enter: Processing methods	0.214	0.074	180.225	61.983	2.908	0.005
Fourth variable to enter: Sowing month	0.208	0.067	153.340	49.204	3.116	0.002

Source: Field Survey, 2018. (b*) are the standardized regression coefficients. b coefficients that are not standardized.

Table 17. Gender and labour questions.

Category	M	W	C	M/W	M/C	W/C	M/W/C	None
Tree cutting	107			2	1			
Tillage	6			93	3		8	
Clearing the field	24			34	2		50	
Opening the grooves	49							61
Sowing	7	34		69				
Ground cover	1		9	68	11	3	18	
Bird control	9		93		8			
Rabbits control	7		21		32			50
Fertilization	21	9		21				59
Weeding	2	11		42				55
Harvest				64	4		42	
Threshing		1		102	4		3	
Processing		11		92	2		5	

Source: Field Survey, 2018.

One of the fundamental aspects is the total independence of each plot in terms of the flooding and drainage. This is possible, given the well carried leveling of the land.

Soil preparation at the level of business sector

The ground leveling is an aspect that deserves more attention during the preparation of the soil, because when it is poorly done, it hinders the drainage and the aeration of the soil and the nutrients are easily dragged. This operation is carried out by means of a tractor that draws a leveling blade controlled by a system emitting laser beam that allows to maintain the same dimension of the ground, leaving it as uniform as possible. Regarding laser land leveling, Meena *et al*., (2014) advocate that this system allow the leveling between 0 to 0.2% slopes so that there is uniform distribution of water, enhancing resource use efficiency. Land laser leveling allows a 4% rise in area under cultivation due to the removal of bunds and channels; saves 10-15% water due to uniform distribution; increases resource (N and water) use efficiency; reduces cost of production and enhances productivity. A precisely leveled field is therefore an important prerequisite for successful direct-seeded rice cultivation.

Ground correction

For acidity correction (pH=4.5) of the soil it is applied 1 ton ha^{-1} of calcium carbonate ($CaCO_3$), adding up to 500 tons for the total cultivated area.

Fertilizing

Although the soil contains a good percentage of organic matter which the content is in the order of 7.4% (Gonçalves, n/d), it is necessary to balance the content of phosphorus (P_2O_5) and potassium (K_2O), because the soil leveling process causes a nutrient imbalance in the soil. Thus, 1.000 $kg.ha^{-1}$ of complex fertilizer containing 7-14-14 (N-P-K) and 3-2-9 (Ca-Mg-S) and vestigial concentration of boron (B), is also applied. This operation is carried out by means of a fertilizer spreader and tractor.

Chemical weeding

In order to prevent the growth of weeds, a pre-emergent herbicide in a concentration of 10 liters of glyphosate in 250 liters of water per hectare is applied.

Sowing

The type of sowing is direct, and is done mechanically. On average, 65 kg.ha^{-1} are sown in rows of 20 cm apart and at a depth of 2 to 3 cm.

Varieties

The seed variety used is type UN10 from the Chinese company WINAll Seeds. Before sowing, it is made a germination test. This consisted in placing 100 seeds in water for 7 days and that resulted in a 98% efficacy of germinated power. The UN10 has a cycle of 150 days meaning that, if the sowing date is late this cycle is forced, implying early maturation, and thus compromising the yield of the crop. Thus, it is important that the sowing date occur in the months of October to November, never going beyond mid-January.

The flooding of beds

This process starts 3 days after sowing and uses two turbines pumping 600 l.s^{-1} of water with the engine running 24 h a day. At the same time, the irrigation channel floodgates are opened to allow gradual flooding of already sown plots. It usually takes 48 h of continuous water flooding to achieve soil saturation. The expected productivity with this technology is around 6.000 kg.ha^{-1}.

Production destination

The rice produced is harvested with 20 to 21% moisture content, than artificially dried to 13% moisture and, finally, stored in the husk. Afterwards, it is peeled, bagged and sold. Potential buyers are the armed forces, population of different points of the country in particular of the provinces of Bié, Huambo, Benguela and Moxico. The company supports the Agrarian Development Institute by distributing seeds to the peasant families with the aim of promoting rice production in every municipality. This data is important to mapping the market chain.

Water management

As a permanent flooding system, the farm has the Kuquema River as a source of water. Once the cultural cycle is finished, the extra water is drained back into the river. When the water level in the Kuquema is high, this drainage needs to be done with the support of the Pumping Station. This data is important for assessing the environmental impact of wastewater on the Kuquema River aquatic ecosystem.

Differences and Similarities between the business and the traditional rice sectors

Table 18 refers to the factors that make it possible to distinguish the two production systems in terms of the technology used. According to this data, it is noticeable that there are great differences in terms of the Systematization of the field, the Cultural Operations, the Harvest, the Threshing, the Processing and the Destination of production and in the equipment used. However, there is the similarity that both the business and the traditional sectors use the direct sowing method. The difference is that while for the traditional sector, the sowing method is manual, and in most cases, it is broad casting, in the business sector, it is completely mechanized**.** The rice value chain in the business sector is complete whereas in the traditional sector it is very fragmented and has no mechanized tools for processing rice to obtain grain quality. Rice cultivation in the traditional sector is motivated by the food family need, the tradition, the habits and the customs of the region, while for the business sector cultivation is motivated for commercial purposes, which imposes the permanent quality improving of the grain to make it increasingly competitive in the market. All the advantages fall to the business sector that make a big investment that translates into the final yield and economic return of the culture.

Table 18. Differences and similarities between the business and the traditional rice sectors,

Technical Itinerary	Business sector	Traditional sector
Systematization of the field	Road network Pump station Watering ditches Ditch ditches	In some cases

Source: The authors

Table 18. Contd.

Cultural Operations	Mechanized tillage Ground leveling Correction of soils Chemical weeding Gradation Fertilization Direct sowing Opening irrigation canals Field flooding Application of herbicides	In some cases only if the sowing is direct on line Is not applied In some cases only In some cases only In some cases only Is not applied In some case Is not used
Harvest and threshing	Combine harvester	Is usually made with knife or sickle
Drying	Determination of moisture content (Dryer)	Extend on tarpaulins
Storage	Silos or in bag of 5, 10, 25 and 50 kg	Store in bags/bottles
Processing	Mechanized (Use of debarking machine)	Handcrafted (artisanal)
Destination of production	Farmers Agrarian Development Institute Armed forces General Population	Consumption Seed Conservation Sale
Equipment	Heavy disc harrow Tractor fertilizer spreader Tractor with rotating Disc harrow Leveler Tractor Rotary Excavator Seed drill Combine harvester	Manual Instruments

Source: The authors

Conclusion

The rice production has been widely practiced during last several decades in Camacupa and Catabola municipalities. The farmer's survey described in the present study identified several short to long-term measures to enhance the productivity and production needed to meet the growing demand of future years. The rural population, despite being mostly young does not have nevertheless sufficient preparation, knowledge, means and motivation to be able to develop an efficient agrarian activity. This situation is aggravated by the fact that among farmers there is still a predominance of subsistence agriculture, with a non-commercial, non-productive and unprofessional vision. Rice-rice-rice is the dominant cropping patterns in the village. Farmers' practice of rice farming is highly inconsistent with recommendation practice in terms of time of establishing crops, seeds and fertilizers rates and pesticides. A typical example is the fact that farmers apply lower doses of fertilizers due to lack of knowledge and money.

Women are intensively participating in post-harvest processing of crops and other household activities as well as households decision other than farming. In short, rice production is of the great interest of farmers. However, poor access to extension service, lack of good quality seed, phosphorous fertilizers, pesticides and power supply were identified as barriers to achieve better performance of rice production and expected higher returns. Overcoming these bottlenecks and better price conditions may enhance better farm productivity and profitability in rice production. Lack of control of crop enemies, non-use of fertilizers and adequacy of sowing date in relation to the varieties used are some of the factors that underlie low productivity. The study concluded that the final production achieved by each farmer can be essentially explained by four variables: Number of controls (with an explanatory power of 43%); Age of producers (with an extra explanatory power of 2. 5%); Processing method (with an extra explanatory power of 6.5%) and sowing month (with an extra explanatory power of 3.8%). Those four variables have a total explanatory power of the productivity achieved by the farmers of 55.8%. Thus measures relating to the expansion of field schools with a view to giving farmers adequate knowledge of appropriate cultivation methods and establishing a partnership especially with regard to rice processing between business and traditional sectors would be key to leveraging the agricultural rice sector in the region.

Authors' declaration

We declared that this study is an original research by our research team and we agree to publish it in the journal.

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