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COMPARATIVE STUDY OF THE PROFITABILITY OF THE CULTURE OF IRRIGATED RICE SMOKED WITH UREA AND AZOLLA IN FERRALITIC SOIL IN KISANGANI.

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Abstract- ***Our study is enquiry dealing one the essays realized by LUKUSA (2001) and MOTUTE (2002) one the irrigated rice. The authors cuts realized the comparative studies of the answers of has local variety of rice in the burying of green manure, Azolla pinata, and in to spread of ur E has in A shallow hydromorphic in Kisangani. The obtained result hood shown that 6 Tone of dry matter of green manure produced in the field from year inoculums of 0,50 kg of Azolla/m ^{2} had has fertilizing power equivalent to 80 kg N/ha coming from 173,83 kg/ha of ur E has dosing 45% of nitrogen. The obtained yields with the green manure being statistically similar and significantly superior to this obtained with the not fertilized witness, the authors had concluded that in their experimental conditions, the green manure Azolla could Be substituted advantageously in ur E has.***

The present enquiry aims At testing the economic implications of obtained results by the authors cited beyond by comparing the misses of respective rent ability of applied treatments.

For obtaining the necessary dated to the estimate of the rent ability misses of different farming technical, we cuts used the technical of enquiry per documentation and interview.

In the first box, we cuts consulted the accountant documents of Institute Faculty of Agronomic Sciences, IFA in shorts. In the second box, we cuts interrogated the researchers, the technicians and the workers of IFA who had participated to the experimentation. We cuts also to collect has complement of information near the persons implicated in the culture and the commercial circuit of rice.

The parameters dealt for our enquiry are the following.

- ***The funds used in the preparation of the ground including:***
  - ***The clearance and the plowing;***
  - ***Fitting-out of irrigation system and the drainage.***
- ***The funds of to sow of the culture including:***
  - ***Installation of seed bed.***
  - ***To transplant.***
- ***The funds of acquisition of seeds and of intrants***
- ***The funds of implementation of green manure.***
- ***Agricultural The fund of purchase of material.***
- ***The fund of maintenance***
- ***The fund of crop, transportation and stocking***
- ***The fund for workers***
- ***The dirty price of crop***
- ***Cultivated surfaces area***

From these parameters, we cuts determinate the following variable: the production, the cost of production the income, the rough profit margin and financial rent ability of different farming technical.

The obtained results cuts shown that the cost of the work relative to the ascribable utilization of Azolla is inferior to this to ur E has, aim relatively superior to that of the traditional method of production. One the agricultural plan of utilization of tool, the treatment in Azolla revealed identical to the traditional method, aim neatly less expensive then the ur E A. The Azolla permits then has to go along utilization of agricultural tool.

The increasing of the cost of production in particular this of the lab our due to the fertilization, went with the improvement of the rough production and the income more significant under Azolla than under Ur E A. The beneficiary profit margin is remained however negative under all the treatments, more negative render the urea and the traditional method than under Azolla, to lead to the respective financial lost of the order of 433; 690 and 633$/ha. In relation to witness, the relative lost were of 0, 68 and of 1, 09, respectively under Azolla and urea indicating hence the Net superiority of the first one the second and one the traditional system of production.

In splashes of the negative result in the first culture, it is permitted to hope the profitability of the uses of Azolla in length term, thanks to the favorable share of back effect of organic matter one the fertility of soil. The rent ability edge however Be more quickly improved by reducing the cost of work.

0. INTRODUCTION

The population of the world currently rises to six billion inhabitants (Anonymous, 2001). To nourish this mass of people appears difficult, in particular in the intertropical area which shelters four billion hearts and whose agriculture is not very productive.

Among the reasons which explain the weak performance of tropical agriculture, it is necessary to quote the intrinsic

poverty of the soil and the difficult access to the intrants which may allow to increase soil productivity.

Rice is one of the most cultivated cereals in Africa, the principal edaphic constraints to its production are water and nitrogen (Mambani, 1980). In R.D.Congo, the incapacity to control these factors maintains the average national yield at a level still lower than one ton per hectare (Mambani, 2002). According to Lukusa(2001) and Motute (2002), one can appreciably improve the yield of the irrigated rice in ferralitic soil by bringing nitrogen to the culture through the green manure Azolla and especially that the production of Azolla is possible without fertilization under the experimental conditions of Kisangani (Katumpwe, 2001). The results obtained by these authors showed that the fertilizing capacity of this fern is slightly higher than that of urea, the artificial fertiliser usually used in the fertilization of rice. Azolla as green manure has in addition the advantage of being a non polluting product, compatible with the safeguard of the healthiness of the environment.

The present study proposes to evaluate, from the economic point of view , the profitability of the culture of irrigated rice fertilized with urea and Azolla in Kisangani. The set aim is to contribute in the search of an alternative to the traditional methods of improvement of the hydro morphes ferralitic soils accessible to the local farmers, while being technically effective, economically viable and ecologically safe.

Our study is based on the following assumption. Azolla being one intrant locally available, its cost of acquisition would be low compared to that of the urea, which is a product of importation. Former studies having in addition shown that the cost of implementation of the organic matter is lower than that of mineral manures (Ahundu, 2001; MOT. H umba, 2001), the production of rice would be more profitable under Azolla than under urea.

Thus, this text, in addition to the introduction and the conclusion, includes three essential parts , material, method as well as result and discussion.

I. MATERIEL

- Pen;
- Paper;
- Questionnaire and
- Computer.

II. METHOD

Long time ago, the observation and the experimentation are two essential tools of the progress of sciences (DAGNELIE P, 2003)

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II.1. Experimentation (Lukusa, 2001; Motute, 2002)

The soils of Kisangani derive from the wind depositions and are sandy- argillaceous and acid (Onotamba, 1994). They are generally low in assimilable biogenic salts and rich in aluminium and iron oxides (Dabin, 1981).

After elimination of the thatch and stocks of the first culture, we proceeded to the refitting of the system of irrigation and drainage of the experimental site. From the spring, the principal channel (feeder canal) skirted the ground in its high party, while the primary drain consisted of two channels dug on both sides of the field in the direction of the slope of the ground. A large rack, small floodbanks and small racks inside large were built with ground removed from the channels. Twelve small racks of dimensions 3,20 m X 2,40 m (that is to say 7,68 m ^{2}) gathered four to four so as to form experiment packages used as experimental blocks. Between blocks, secondary drains were dug and poured their water in the primary drains. The experimental design is schematized on figure 1. The ground then was plowed and harrowed in the state of saturation and the racks put underwater. A plat band of 3,10 m X 1,20 m was plowed apart from the experimental field to be used as germoir-seedbed. One kilogramme of seed sorted beforehand by floating was sown there by spreading. The germoir – seedbed was covered with sheets of palm tree to protect the seed and the seedlings against the birds and the rats.

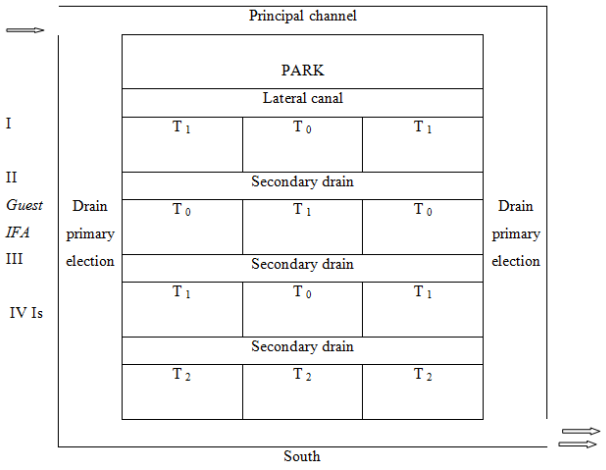
The treatments implemented consisted of the pieces fertilized by incorporation of Azolla (T1) and the Urea (T2), as well as not fertilized pilot pieces (T0).

For the implementation of Azolla, the concerned racks were flooded with a 5 cm height water bed, then sown with a inoculum of Azolla pinata at the rate of 0,50 kg/ha (FAO, 1986). The fern was allowed to grow until reaching the equivalent of 6 tons dry matter per hectare. This quantity was obtained two months after sowing. The racks were then drained and the biomass of Azolla incorporated on the ground by a light ploughing. One day after, rice (Oryza sativa VAr zunguwe) was mended with the spacings of 20 cm X 20 cm, at a rate of three seedlings per site.

The experimental design is schematized in figure 1.

Fig.: 1. Diagram of the experimental design.

North (University clinics)



(Congo River)

Key: T $_0$: Treatment without Azolla nor urea (pilot absolute)

T $_1$: Hidden Azolla

T $_2$: Urea

I, II, III and IV: Blocks

The urea was implemented in furrows traced between the sowing lines 12 days after the road repair of rice, with the amount of 133,5g/parcelle, that is to say the equivalent of 80 kg N/ha.

The percentages of carbon and nitrogen of the ground, the growth in height of rice, the number of tiller, the leaf aera, nitrogen content in the sheets of rice, the number of panicles per seedling, the number of grains per panicle, the rate of sterility, the dry weight of the aerial parts, the weight of

thousand grains and the output in grains were given in order to appreciate the response of the ground and rice to the treatments implemented.

II.2. ECONOMIC SURVEY

To obtain the data necessary to the estimate of the rates of profitability of various farming techniques, we resorted to the techniques of survey per documentation and interview. In the first case, we consulted the book of the Facultaire Institute of Agronomiques sciences, IFA-Yangambi. In the second case, we questioned the researchers, the technicians and the workmen of the Institute having taken part in the experimentation. We also collected a further information near the people implied in the culture and the trade-circuit of rice.

The parameters aimed by our survey were as follows:

- Expenses allocated to the preparation of the ground including:

a. The clearing and ploughing
b. Adjustment of the system of irrigation and drainage

- Expenses of set up of the culture:

a. Installation of germoir –seedbed
b. Road repair

- Expenses of acquisition of seed and the intrants
- Expenses of implementation of the manures
- Expenses of purchase of farm equipment
- Maintenance costs
- Expenses of harvest, transport and conditioning
- Expenses of labour
- Selling price of harvest
- Output
- Acreages

From these parameters, we determined the following variables: production; the production cost; income; the gross margin and the financial profitability of various farming techniques.

II.3.DETERMINATION OF THE VARIABLES

- **PRODUCTION**

In our study, the production is defined as the quantity Q of paddy produced under various farming techniques. It is obtained by multiplying the output by the acreage (MUYASA, I; 1998). the experimental productions obtained with various treatments were extrapolated to the hectare according to the three simple rule.

- **PRODUCTION COST**

It is the invested capital for obtaining a manufacturing unit (MUYASA, I; 1998). This capital (CT) includes the fixed cost (CF) independent of the volume of production on a certain scale and the variable cost (CV), changing according to the volume of production:

$$CT = CF + CV$$

In our case, the fixed costs were represented by the price of seed and the cost of implementation of the agricultural tools. The first was indicated to us by the rice-growing ones and the farmers implied in the trade of rice, while the second was, for each tool, estimated by the relation:

$$CU = (P/T_1)/T_2$$

CU being the cost of implementation, P the purchase price, T_1 lifespan of the tool expressed in a maximum number of taxable hours of work to the tool and T_2 times of effective use of the tool during the cultural season considered, expressed in a number of working hours actually imposed on the tool. The lifespan of the tools used was estimated by calculating the average of the time indicated by the experienced farmers and the Provincial Inspection of the Agriculture quoted by Ahundu (2001) and Motshumba (2001). The working time imposed on various tools was determined by the execution time of the tasks assigned to the workmen using these tools during the cultural season considered. The purchase prices of various tools were obtained by local market survey.

The variable costs were represented by the prices of acquisition and implementation of the intrants, as well as costs of the following operations:

- Preparation of the ground
- Installation of germoir –seedbed
- Road repair
- Weeding
- Guarding
- Collect
- Transport of harvests
- Conditioning of harvests.

The price of transport was that paid to the workmen having transported the harvest from the experimental field to the laboratory of the IFA in Kisangani, extrapolated, for each treatment, to the weight of harvest per hectare. The price of labour was estimated starting from the number of man-days assigned to each operation, the value for the one man-day being fixed at 1USD.

- **INCOME**

According to BOUDINOT et al. (1981), the income is what is perceived in a normal way and whatever the reason by a person or entity. One distinguishes:

- ✓ Income of the capital (interest, dividend);
- ✓ Labour income (wages);
- ✓ Social income (family benefits, settlement of safety, reprocesses).

The income R, is here the rough money value of harvest, i.e. paddy.

It is estimated by the formula:

$R = PQ$

P being the price of one kilogramme paddy and Q the production as defined above, at the point a.

- **STROKE BRUTE(MB)**

The gross margin is the difference between the income R and the corresponding operational charges (MUYASA, I; 1998) :

$MB = R - CT$

- **The RATE OF PROFITABILITY (T_R)**

The rate of profitability is defined by the quotient of the gross margin to the sum of the operational charges (MUYASA, I; 1998). It is determined by the relation:

$T_R = MB/CT$

An activity is the more profitable as this quotent is higher than the unity.

III. RESULTS AND DISCUSSION

III.1. Agronomic aspect

The outputs obtained with the various treatments are presented in table 1.

Table 1. Effect of Azolla and urea on the output in grains of the irrigated rice (Kg/parcelle) in a ferralitic hallow of Kisangani.

Repetitions	Manure		
	WITHOUT	AZOLLA	UREE
I	0,891	2,433	2,631
II	0,858	2,016	0,997
III	1,096	1,864	0,534
IV	0,539	2,655	1,214
Total	3,38	8,97	5,38
Average	0,85(1,11)	2,24(2,92)	1,34(1,74)
PPDS $_{0,05}$ for the averages			0,90
Relative averages	1,00	2,64	1,58

Source: MOTUTE(2002)

Key: PPDS $_{0,05}$ = the smallest significant difference with the threshold
of probability of 5%. The numbers in parentheses represent average outputs converted into t/ha, compartmental surface being of 7,68 m ^{2}.

It appears that the output varies with the treatments implemented, the fertilized pieces having produced more than the witness not smoked. The relative outputs compared to the witness not fertilized, show that Azolla and the urea improved the output in grains by 164 and 58% respectively. The separation of the averages by the method of the smallest significative difference (PPDS) showed that the differences observed on the one hand between Azolla and the urea and on the other hand between Azolla and the witness are significant with the threshold of probability of 5%, while those between the witness and urea are not (Motute, 2002).

III.2. Economic aspects

III.2.1. Cost of work

The cost of work expresses the expenditure engaged in exchange of provided work. One evaluates it in currency. Table 2 shows the costs of work recorded under various treatments.

The results show that the use of Azolla and urea are more expensive than the witness not fertilized. Indeed, the results of relative costs (traitement/témoin) indicate that the work completed with Azolla is 14% more expensive than that carried out with the witness, while the surplus of expenditure caused by the fertilization with urea amounts to 18%.

The comparison between urea and Azolla reveals that this last caused a cost relatively weaker than the first, the urée/Azolla quotient being of 1,04. This indicates that the increase in work under urea is 4% compared to Azolla. In monetary term, one can say that the use of Azolla or urea causes the respective additional expenditure of 91,62 and 119,4$.

Table 2. Effect of urea and Azolla on the cost of work.

OPERATIONS		COST IN $ US/HECTARE		
		Without manure	Azolla	Urea
Preparation of the ground	Clearing	108,51	108,51	108,51
	Racks	108,51	108,51	108,51
Germoir-seedbed		27,13	27,13	27,13
Intrants	Acquisition	0,00	21,70	42,00
	Implementation	0,00	21,70	32,55
Road repair		81,38	81,38	81,38
Maintenance of the culture	Weeding	15,19	0,00	37,98
	Guarding	270,00	270,00	270,00
Collect		15,65	41,17	24,53
Transport of harvest		10,08	26,25	15,70
Conditioning of harvest		13,32	35,04	20,88
TOTAL		649,77	741,39	769,17
Relative costs (traitement/témoin)		1,00	1,14	1,18
Urea/Azolla 1,04				

Source: personal calculation

The results show that for all the studied treatments, the guarding and the preparation of the ground remain the most expensive operations. The expenditure due to guarding accounts for 42, 35 and 34%, respectively under the witness, Azolla and urea, while the preparation of the ground respectively absorbed 33,29 and 28% of the expenses of work completed with the witness, Azolla and urea.

While comparing the costs and the relative outputs recorded under various treatments, it is obvious that additional work in the treatments Azolla and urea led to the increase in the outputs.

III.2.2. Total capital

The total capital consisted of the cost of implementation of the minor farm equipment and the value of the seed.

III.2.2.1. Use of farm equipment

Table 3 shows the value of use of the material placed at the disposal of the personnel in charge of the project.

Table 3. Value of use of the farm equipment (fixed cost)

Material	Numbers	Utilisation period (campaigns)	Price of achat($)	Value of US use $/hectare		
				Without manure	Azolla	Urea
Machetes	10	2	20,00	10,00	10,00	10,00
Hoes	15	4	61,50	32,98	32,98	65,97
Cords	5	4	40,00	10,00	10,00	10,00
Goblets for spreading of manure	10	1	0,80	0,00	0,00	8,00
TOTAL				52,98	52,98	93,97
Relative securities				1,00	1,00	1,77

Source: personal calculation

Table 3 shows that the cost of implementation of farm equipment is identical under the witness and Azolla, while it is higher under urea. The results of relative costs indicate that with urea, the use of the material is 77% more expensive than with the witness or Azolla. The practical significance of this

difference is that the production of rice by fertilizing ground with urea causes a faster wear of the tools and requires consequently a more frequent replacement of the equipment. This suggests that in the long run, the investment is more expensive to the owner who uses this farming technique than to the one employs the green manure in the form of Azolla.

III.2.2.2. The working capital

The working capital is, in our case, the cost of rice seeds. It raised to 108,51$/ha for each treatment implemented.

III.2.2.3. Synthesis of the costs

Table 4 gives the synthesis of all the production costs.

Table 4. Total cost of production in American dollars

COST	MANURE		
	Sans(T_0)	Azolla(T_1)	Urée(T_2)
Work	649,77	741,39	769,17
Capital	161,49	161,49	202,48
TOTAL	811, 26	902,88	971,65
Relative costs (T_0 / T_1)	1,00	1,11	1,20

Source: personal calculation

The results show that the total cost of production is higher under the manure than under the witness. The increase in cost is 11% with Azolla and 20% with urea, indicating that the first is relatively less expensive than the second. The profits of output corresponding to these increases in costs are 58 and 164%, respectively under urea and Azolla. The total cost of production caused by urea is 8% superior to that recorded under Azolla, that is to say a difference of 68,77$. On the other hand, the production obtained with urea reaches hardly 60% of that obtained with Azolla, which corresponds to a deficit of 1,18t/ha. One can thus think that being less expensive than urea but more producing, Azolla can offer more profit than this last.

IV.2.3. Income

According to BOUDINOT et al. (1981), the income is what is perceived in a normal way and whatever the reason by a person or entity. One distinguishes:

- Income of the capital (interest, dividend);
- Labour income (wages) and
- Social income (family benefits, settlement of safety, reprocesses).

The incomes generated by various treatments are shown in table 5.

Table 5. Results of production obtained with various treatments

VARIABLES	MANURE		
	Sans(T_0)	Azolla(T_1)	Urée(T_2)
Unit price ($/kg)	0,16	0,16	0,16
Quantity produite(t/ha)	1,11	2,92	1,74
Value of production ($/ha)	177,60	467,20	278,40
Relative value (T_I / T_O)	1,00	2,63	1,57
Azolla/urée report			1,68

Source: personal calculation

The results (T_I / T_O) show that the implementation of Azolla allowed an improvement of income of 163%, against 57% obtained with urea, thus indicating the clear superiority of the first on the second. These increases show that if the fertilization of the ground appears expensive, it compensates the effort of production by the release of a more consistent income than that obtained in a traditional exploitation not practising the land improvement. The results also show that the use of Azolla generates an income definitely higher than that obtained with urea, the Azolla/urea quotient being of 1,68.

IV.2.4. Profit margin and profitability

The results of profit margins and rates of profitability obtained with various treatments are shown in table 6.

Table 6. Calculation of the profit margin and the rate of profitability.

Manure	Value of production	Production cost	Income/Cost	Profit margin	Rate of profitability
	(1)	(2)	(1)/(2)	(3)=(1)-(2)	(3)/(2)
Without	177,60	811,26	0,22	-633,66	-0,78
Azolla	467,20	902,88	0,52	-435,68	-0,48
Urea	278,40	971,65	0,29	-693,25	-0,71

This table shows that for all the treatments implemented, the profit margin and the rate of profitability are negative, while the revenu/coût quotient remains lower than the unity.

The practical significance of these results is that the resources invested in the production are by no means recovered, the project having functioned at a loss. One can note however that the undergone losses vary considerably with the treatments implemented: they are 48; 71 and 78%, respectively under Azolla, urea and the witness not fertilized. These losses correspond to respective financial deficits of about 433; 690 and 633$.

The fertilization in Azolla can thus be regarded as a farming technique forwarding less risk at the investment than commercial urea, in particular in a continuous farming system. Indeed, in continuous system, one can capitalize on the favorable consequences of the back effect of the organic matter brought by Azolla on the fertility of the ground. In addition, in a continuous system, the irrigation and drainage device is not maintained permanently, which reduces the cost of the labour because the installation being already made, it will not cost any more but a light maintenance.

CONCLUSION

Our work aimed to compare the effects of the fertilization with urea and the green manure Azolla on the profitability of the rice irrigated in a hollow of Kisangani. The set aim was to contribute in the search of an alternative to the traditional methods of improvement of the ferralitic hydro morphes grounds accessible to the local farmers, whitch is economically viable and compatible with the safeguarding of the environmental quality.

The results obtained showed that the cost of work relating to the use of Azolla is lower than that ascribable to urea, but relatively higher than that of the traditional method of production. Regarding the use of the agricultural tools, the treatment Azolla proved to be identical to the traditional method, but definitely less expensive than urea. Azolla thus allows a longer use of the agricultural tools.

The increase in the production cost, in particular that of labour due to the fertilization, was accompanied by the improvement of the production and the gross income, more significantly under Azolla than under urea. The profit margin remained however negative under all the treatments, more

negative under urea and the traditional method that under Azolla, causing respective financial losses of about 433; 690 and 633$/ha. Compared to the witness, the relative losses were 0,68 and 1, 09, respectively under Azolla and urea, thus indicating the clear superiority of the first on the second and on the traditional system of production.

In spite of the negative result in first culture, it is allowed to hope for the profitability of the long-term use of Azolla, thanks in particular to the favorable actionof the back effect of the organic matter on the fertility of the ground. Profitability can be in addition more quickly improved by reducing the cost of the work. Thus we may formulate the following recommendations:

- On the technical level, that the farming methodsimplying minimum cultivation be tested in the long run;
- On the plan of the agricultural policy, that the authorities institute mechanisms of regulation and effective control of the prices paid to the producers, considering the existing considerable difference between the price of paddy and that of the milled rice which, currently, wrongfully supports the tradesmen to the detriment of the producers, which plays inevitably in discredit of the development of the rural mediums.

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