

Socio-Economic Impact of Corn Fielding in The Iffou Region of Eastern Central Ivory Coast

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Abstract— In the present paper, the socioeconomic impact of weed control (manual and chemical + manual) of maize field technologies is assessed using indicators such as cropland, weed control, yield, total cost, gross margin (production value), net margin and net income. The article shows that in the Iffou region of Ivory Coast, where grass cover is a major problem, the use of herbicide reduces weed control time, contributes to solving the problem of scarcity and high cost of labor, and the positive effects on these indicators compared to manual weeding. However, the incidence of the use of herbicide remains low in relation to the number of farmers.

Index Terms— Iffou region, corn crop, weeding techniques, socio-economic impact.

I. INTRODUCTION

Maize, which is grown in Ivory Coast as in other African countries, has the advantage of being harvested early after the milk stage. It is thus the first cereal available in the agricultural calendar and allows to get through the end of the lean season. Corn also makes it possible to obtain the first financial resources by the marketing of fresh spikes which are intended to be braised or boiled. This gives it important food and financial roles for farmers.

The cultivation of maize, once limited to the northern part of Ivory Coast between latitudes 8°N and 11°N [12], is now present throughout the national territory. But the northern part of Ivory Coast still remains a great expanse of maize production. The traditional cultivation system (manual and extensive) remains dominant with large areas under development. Despite the increase in cultivated areas, corn yields at the national level are still low (0.8 t/ha on farms compared with 2 to 5 t/ha in a research-controlled environment [12]. For example, in 2014, with a cultivated area of 308,839 ha, production is estimated at 654,738 t, yielding 2.12 t/ha [13]. Food crops, in general, are

experiencing steady and accelerated declines, which can be described as an alarming situation, part of which is attributed to grass cover [9]. However, this region has reclaimed land that is suitable for agriculture after thirty years of fallow.

According to [9], weed competition is one of the constraints to large-scale cereal production in Ivory Coast. The difficulties inherent in weed control by farmers would be one of the reasons that most often oblige the farmers to abandon old plots to create new plots [2]. Suitable weed control measures are traditional.

The farmers of Iffou, faced with the aforementioned difficulties, are increasingly using herbicides on corn crops notwithstanding the fact that their use is still low. Thus, for farmers the use of herbicides is a solution to the problem of weeding the plots, which makes it difficult to carry out manual weeding. Chemical weed control contributes not only to solving the problem of labor shortages, but also to increasing cultivated areas and agricultural production. It also reduces weed control time and improves technical weed control sequences. Needless to say, the introduction of herbicides as a factor of production, although recent, has an impact on the socio-economic variables that characterize farmers. The aim of this paper is to assess the impact of maize field weed control techniques on socio-economic indicators in the Iffou region. In other words, this evaluation consists of selecting socio-economic indicators and comparing the impact of weeding techniques used in the Iffou region, namely manual weeding and chemical + manual weed control on these indicators. This paper is structured into three parts. The first part presents the study material and the methodological approach. The second part presents the results and the third part relates to the discussion.

II. MATERIALS AND METHODS

A. Study material

Study zone

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The study area is the Iffou region composed of regional departments of Daoukro, M'Bahiakro and Prikro, located in central-eastern Ivory Coast. The choice of region is based on the elements described below. This area once belonged to the former cocoa belt, but from 1980 onwards has suffered several natural disasters such as drought, locusts, rainfall deficits and soil depletion [14]. The abandonment of cash crops (coffee, cocoa) as a result of these natural calamities has made possible, after thirty years, the regeneration of land which has once again become suitable for agriculture. In addition, food crops are low yielding and the introduction of chemical weed control is recent.

The region covers an area of 8,955 km² or 2.8% of the national territory. The relief, which is fairly flat, is largely made up of plateaus. There are shallows, watersheds, ferrallitic soils and ferruginous soils [16] – [17]. The region straddles forest and savanna. According to [3] – [8] the region presents attian-type climate (2 rainy seasons and 2 dry seasons), Baoulé-type climate (transition between 4 climate season in the south and 2 climate seasons in the north) and Sudan-type climate (2 seasons: a long dry season and a short rainy season).

The population number of the region is estimated at 311,642 inhabitants [15]. It is populated by indigenous people (Baoulé, Agni, N'Gain and Andoh), non-natives (Sénoufo, Malinké) and non-Ivorian nationals from the Economic Community of West African States (ECOWAS) composed of Burkinabes and Malians. Agriculture is the main economic activity carried out by this population. The crops grown are varied, d include cash crops (coffee, cocoa, rubber, cashew nuts and oil palm), food crops (yam, cassava, bananas, plantains, rice, corn and peanuts) and food crops (eggplant, okra, chilli, tomato, cabbage, squash, courgette, pepper, carrot, melon and onion). In addition to these crops, livestock (cattle, sheep, goats, pigs and poultry) and fisheries are underdeveloped.

B. Biological and technical materials

The biological materials include corn (*Zea mays* L. Poaceae) grown in the Iffou region and weeds from the corn fields. These weeds are *Mucuna pruriens* or *Imperata cylindrica* for

which the weeding techniques used are manual weeding (T1b) and chemical + manual weeding (T2b). Manual weeding is the control of weeds such as *Mucuna pruriens* or *Imperata cylindrica* which are difficult to weed manually. The chemical + manual weed control uses a total herbicide which eliminates these weeds wherever they are present on the sprayed plots. Then, the weeds that have been killed by the herbicides are cleared using a machete, hoe or daba. The technical equipment is composed of a Global Positioning System (GPS), GPS toggle widget, survey cards and computer software. The GPS was used to locate survey sites and to measure sown areas. The scale was used to weigh the outputs obtained. The survey sheets were used to gather information on the ground. The data were entered and processed using software, SPSS, EPIDATA and EXCEL. The XLSTAT software made it possible to undertake Student's t-tests.

C. Methodology

Field survey data

The information used in the present paper comes from the body of literature and the survey was conducted between May and August 2014 in the Iffou region as part of our field research activities. Our aim was to gather information on the region and the farmers cultivating the food products. This information relative to each department is geographical, socio-professional, demographic, agronomic and economic.

Data analysis method

Descriptive statistics in the form of simple descriptive analyses were used. The simple descriptive analysis approach consists of giving the main characteristics of each variable which are taken in isolation and then crossing two variables. Thus, agronomic and socio-economic variables were analyzed.

Determination of the socio-economic impact of weeding techniques

Determining the socio-economic impact of weed control techniques involves socio-economic indicators such as cultivated area (CA), weed control time (WCT), yield (Y), total cost (TC), gross margin (GM), net margin (NM), net income (NI), total unit cost (TUC), unit selling price (USP)

and the TUC / USP ratio. These indicators are defined as follows:

- **Cultivated area (CA)** = the average cultivated area expressed in hectare (ha) is the ratio of the total area and the total number of farmers surveyed;
- **Weeding time (WT)** = time spent by farmers on weeding in hours / ha;
- **Yield (Y)** in kg / ha = the ratio of production to area;
- **Total cost (TC)** in CFAF / ha = the sum of the costs of the factors of production used: cost of herbicide (CH), cost of salaried labor (CSL), cost of seed (CS). The cost of the sprayer which is assessed on the basis of the annuity (CoS);
 $TC = CH + CSL + CS + CoS$;
- **Gross margin (GM)** or production value (PV) expressed in CFAF / ha = product yield (Y) obtained and the unit selling price (USP); $GM = Y \times USP$;
- **Net margin (NM)** expressed in CFAF / ha = the difference between the gross margin and the total cost; $NM = GM - TC$;
- **Net income (NI)** expressed in CFAF = the product of the net margin and the cultivated area (CS); $NI = NM \times CS$;
- **Total unit cost (TUC)** expressed in CFAF / kg = the ratio of the total cost and the yield;
- **Unit selling price (USP)** expressed in CFAF / kg = the price at which the farmer sells one kg of corn;
- **Ratio TUC / USP** = the ratio of the total unit cost and the unit sale price. Expressed in %, this ratio indicates the share of the total unit cost in the unit selling price.

III. RESULTS

A. Socio-economic characteristics of peasants

The socio-economic characteristics of farmers according to cornfield weeding techniques prior to sowing are age, educational attainment, household labor (HL), wage labor (WL), patterns of access to land, tools used, and number of weeding sessions after sowing (Table 1).

In reference to the weeding techniques prevailing in the region, the farmers surveyed are distributed as follows: 69.82% undertake manual weeding and 30.18% undertake chemical and manual weed control. The average age of farmers who use manual weeding is 37 years (minimum 26 and maximum 48 years) compared with 30 years (minimum

24 and maximum 36 years) for those undertaking chemical and manual weed control.

Level of education

In this region, 60.96% of producers are illiterate. In the regional departments of Daoukro, M'Bahiakro and Prikro, the percentages of educated people are 48.73%, 37.09% and 31.39%, respectively. With regard to manual weeding, the percentage of illiterate producers is 60.93%. In this case, 27.92% of farmers at the primary level are illiterate, 29.05% of farmers at the secondary level are illiterate, and 43.01% of farmers at the upper level are illiterate. With regard to chemical + manual weed control, the percentage of illiterate farmers is 38.95% with 36.08% at the primary level, 34.02% at the secondary level and 29.89% at the upper level.

Household labor and wage labor

Manual weeding employs an average of 9 agricultural workers (6 employees and 3 household workers) versus 3 workers (1 employee and 2 household workers) in chemical and manual weed control. In the region, 87.79% of the food crop farmers interviewed grow crops without wage labor. Nevertheless, the percentages of salaried labor are 35.41% in Daoukro, 33.49% in M'Bahiakro and 31.10% in Prikro.

Modes of access to land

In the region of Iffou, 87.03% of farmers inherited the plots they cultivate. But, there are interest-free loans and leasing of land with royalty income. Concerning interest-free land loans, the percentages of farmers who have acceded to land through this mode are 14.18% in M'Bahiakro, 10.18% in Daoukro and 9.09% in Prikro. As for leasing of land with royalty income, the percentage of farmers is 1.09%, 2.55% and 1.82% respectively in Daoukro, M'Bahiakro and Prikro.

For manual weeding, 83.56% pertain to inheritance, 21.76% pertain to interest-free loan and 13.33% pertain to the land leasing with royalty income. On the other hand, with regard to chemical + manual weeding, 16.44% pertain to inheritance, 78.26% pertain to interest-free loan and 86.66% pertain to land leasing with royalty income.

Tools used

Manual weeding before sowing is undertaken using traditional tools (hoe, daba and machete). As for the chemical + manual weed control, herbicide is first used then there are interventions using traditional tools.

Table 1: Socioeconomic characteristics of farmers by type of weed control

Type of weeding	Average age	Level of education	HL	WL	Ground access modes	Tools used	N° of Weeding sessions after sowing
Manual (T1b)	37	60.93% illiterate	3	6	83.56% heritage	hoe, daba, machete	3
Chemical + manual (T2b)	30	38.95% illiterate	2	1	16.44% heritage	Herbicide + (hoe, daba, machete)	2

Source: Own survey data

Table 2: Evaluation of socio-economic indicators by weed control type

Types of weed control	Surface area cultivated (ha)	Weed control time (h/ha)	Yield (kg/ha)	Total cost (CFAF/ha)	Gross margin (CFAF/ha)	Net margin (CFAF/ha)	Net income (CFAF)
Manual (T1b)	0.2175	256	2,200	50,000	176,000	126,000	27,405
Chemical + manual (T2b)	2	3	3,690	51,000	295,200	244,200	488,400

Source: Own survey data

Number of weeding sessions after seeding

The results of the survey show that the most frequent occurrence of weeding in the three regional departments (Daoukro, M'Bahiakro and Pri kro) is 36.53% per cropping cycle. In Daoukro the most observed weeding frequency is four times greater than in Pri kro. However in M'Bahiakro, the most recorded frequency is double that of Pri kro. By considering the types of weeding technique, the average number of weeding sessions after seeding is three (3) for farmers employing manual weed control versus two (2) for farmers employing chemical + manual weed control.

B. Socio-economic impact of weeding techniques

The socio-economic indicators used (Table II) to evaluate the impact of weed control techniques used by farmers include crop area, weed control time, yield, total cost, gross margin (production value), net margin and net income.

Average cultivated area

The average area cultivated using weed control techniques is 0.2175 ha for manual weed control and 2 ha for chemical + manual weed control.

Weed control time

The average manual weed control time is 256 ± 0.42 h / ha compared with 3 ± 0.44 h / ha in chemical + manual weed

control. At the 5% threshold, analysis of variance using Duncan's test shows a significant difference between the two techniques in terms of time spent on weed control. Manual weed control requires more time than chemical + manual weed control.

Yield

In terms of yield, manual weed control and chemical + manual weed control enable farmers to produce 2,200 kg / ha and 3,690 kg / ha, respectively. The chemical + manual weed control allows the farmers to have a better yield.

Total cost: The spending of farmers on manual weed control and chemical + manual weed control is 50,000 CFAF / ha and 51,000 CFAF / ha, respectively (throughout this paper, CFAF denotes currency denomination of Central French African Francs)

Gross margin (production value)

As for the gross margin, it is 176,000 CFAF / ha for manual weed control and 295,200 CFAF / ha for chemical + manual weed control.

Net margin: With regard to the net margin, manual weed control gives farmers 126,000 CFAF / ha compared to 244.200 CFAF using chemical + manual weed control.

Net income: With respect to net income, it is noteworthy that it is 27,405 CFAF for manual weed control and 488,400 CFAF for chemical + manual weed control.

Ratio TUC / USP

In addition, comparing the average selling price and the average total cost of maize allows us to situate the importance of the cost of production in relation to the selling price of the product. This importance is assessed by the ratio of total unit cost to unit selling price (TUC / USP). This ratio is an indicator of financial profitability which is a decision-making element in the adoption of a technology. Here, this ratio indicates that the expenditure incurred in manual weed control represents 28.75% of the selling price of corn against 17.50% for chemical + manual weed control (Table 3). This means that chemical + manual weeding is more cost-effective.

Table 3: Comparison of average selling price and average total cost of corn in CFAF / kg

Type of weed control	Manual (T1b)	Chemical + manual (T2b)
Unit selling price (USP)	80	80
Total unit cost (TUC)	23	14
TUC/USP (%)	28.75	17.50

Source: Own survey data

IV. DISCUSSION

In corn crop cultivation, manual weed control still occupies a prominent place on farms in the Iffou region. The proportion of farmers who use this technique attests to this situation with 69.82% employing chemical weed control against 30.18% and employing manual weed control. But the scarcity and high cost of labor are increasingly motivating farmers to adopt new weed control technologies such as herbicides. Even if the cultivated areas remain weak, the results of this study show that chemical + manual control (T2b) of weeds such as *Mucuna pruriens* or *Imperata cylindrica* represents 25.64% for these areas. However, the use of chemical + manual weed control increases yield by 67.73%.

Chemical + manual weed control, with 244,200 CFAF, has a higher net margin / ha than that recorded for manual weed control, which is 126,000 CFAF / ha. On the other hand, the labor costs of these weed control techniques are 20 500 CFAF / ha and 30 000 CFAF / ha, respectively. This analysis shows that the net margin obtained / ha for a type of weed control is higher than the cost of the employed labor force used. These results are in accordance with results of the research work of several authors, such as [1] – [4] – [5] – [6] – [7] – [10] – [11]. In terms of net income, these results are also verified. Thus, chemical + manual weed control has a net income

(488,400 CFAF) that is higher than that of manual weed control (27,405 CFAF). This information from the analysis of our data shows the importance of the use of herbicide in terms of wealth creation for farmers. In addition, the analysis of the ratio of total unit cost to unit selling price (TUC / USP) supports the results obtained above. Indeed, this ratio shows that to obtain 100 CFAF of the production value, the farmer spends 28.75 CFAF for manual weed control against 17.50 CFAF for chemical + manual weed control. It would be appropriate to suggest the use of herbicide for weed control in food crops and perennials.

Overall, the benefits of using herbicide could increase incentives for farmers to use this technology. These advantages can be summarized in a few points. The use of herbicide not only allows farmers to develop large areas at lower cost, but also increases the yield of corn crops. In addition, the net income from chemical + manual weed control is higher than that obtained by manual weed control. This financial gain could contribute to an improvement in living conditions for farmers.

V. CONCLUSION

The introduction of herbicide use in the Iffou region appears to provide a solution to the major problem faced by farmers; that of the grassing of plots that are overgrown with weeds such as *Mucuna pruriens* or *Imperata cylindrica*. From a socio-economic point of view, chemical + manual weed control has positive effects on indicators such as cultivated area, weed control time, yield, total cost, gross margin (production value), net margin and income compared to manual weed control. Moreover, the use of herbicide makes it possible to resolve the labor problem with respect to its scarcity and high. For better promotion of the use of herbicides, extension agents of rural structures such as the National Agency for Rural Development Support (ANADER), Ivory Coast should sensitize, train and motivate farmers to adopt this new cropping technique. In that, the use of herbicide, which is a chemical substance, can be harmful to users and their environment. Herbicide can negatively impact their living environment via contamination of groundwater

and watercourses, for example, if it is used in an uncontrolled and abusive way.

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Annex 1: Calculation of socio-economic indicators by type of weed control technique

Variable	Manual weed control (T1b)	Chemical + manual weed control (T2b)
Cost of seed (CS) CFAF /ha	20,000	20,000
Cost of salaried labor (CSL) CFAF /ha	30,000	20,500
Cost of herbicide (CH) CFAF /ha	-	4,500
Cost of sprayer (CoS) CFAF /ha	-	6,000
Total cost (TC) CFAF /ha	50,000	51,000
Yield (Y) (Kg /ha)	2,200	3,690
Total unit cost (TUC) (CFAF /kg)	23	14
Unit selling price (USP) (CFAF /kg)	80	80
Gross margin (GM) or Production value (PV) CFAF /ha	176,000	295,200
Net margin (NM) CFAF /ha	126,000	244,200
Income (CFAF)	27,405	488,400

Source: Own study data. CFAF denotes currency denomination in Central French African Francs.

Annex 2 : Comparison of socio-economic characteristics and yields of farmers

Source: Own study data. CFAF denotes currency denomination in Central French African Francs.

Parameters	Type of weed control	Number	minimum	maximum	Average + standard deviation	Student's t-test
Average age of farmers	Manual	176	26	48	37 ± 12.18	4,30
	Chemical + manual	149	24	36	30 ± 10.72	4,30
Surface area	Manual	576	0.1875	0.2475	0.2175 ± 0.03	4.30
	Chemical + manual	249	1.5	2.5	2.00 ± 0.5	4.30
Yield	Manual	576	2,000	2,400	2,200 ± 200	430
	Chemical + manual	249	3,100	4,280	3,690 ± 590	4.30
Total cost	Manual	576	48,000	52,000	50,000 ± 2,200	4.30
	Chemical + manual	249	48,000	54,000	51,000 ± 3,000	4.30
Gross margin	Manual	576	170,000	182,000	176,000 ± 6,000	4.30
	Chemical + manual	249	290,000	300,000	295,200 ± 5,200	4.30
Nett margin	Manual	576	120,000	132,000	126,000 ± 6,000	4.30
	Chemical + manual	249	240,000	248,400	244,200 ± 4,200	4.30
Net income	Manual	576	20,000	34,810	27,405 ± 7,405	4.30
	Chemical + manual	249	400,000	576,800	488,400 ± 88,400	4.30

Annex3: Distribution of farmers according to weed control type

Variable	Manual weed control (T1b)	Chemical + manual weed control (T2b)
Number workforce	176	149
Number spouses	2	1
Number children	4	4
Number workers	9	3
Average surface area (ha)	0,2175	2

T1b : manual weed control of *Imperata cylindrica* or *Mucuna pruriens*;
T2b : chemical + manual weed control of *Imperata cylindrica* or *Mucuna pruriens*.

Annex 4: Comparison of average time and labor coast according to weed control type

Variable	Manual weed control (T1b)	Chemical + manual weed control (T2b)
Number of persons	15	15
Average ± standard deviation (hr/ha)	256 ± 0,42 ^b	3 ± 0,42 ^a
Coast (CFA/ha)	30.000	20.500

Statistical parameters

$dof = 1$

$VR = 10,37$

$p\text{-value} < 0.01^{**}$

Source: Own study data. CFAF denotes currency denomination in Central French African Francs.

VR : Value of the Variance Ratio; CFAF /ha : francs CFA par hectare ; dof : degrees of freedom; $p\text{-value}$: probability value; a, b: means followed by the same letter in a given column are not significantly different from the Duncan test at 5%; ** : statistically significantly different.

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