Analysis of the Impact of Agricultural Input Subsidies Voucher Programme on the Livelihoods of Small Scale Maize Producers in Kirehe District, Eastern Rwanda.

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Abstract: The agricultural sector in Rwanda faces many challenges such as use of poor production methods, soil erosion, decrease in soil fertility, and the low level use of improved agricultural inputs among others. The government through its Crop Intensification Programme implemented in 2007 the Agricultural Input Subsidies Programme. The main goal of AISP was to increase the adoption of improved agricultural inputs among rural small-scale farmers in order to increase agricultural productivity, food security, income generation and subsequently improve the rural people's livelihoods. This study analyzed the impact of agricultural input subsidies programme on the livelihoods of small-scale rural maize producers in Kirehe District by surveying 96 farms selected randomly from a population of 9,854 households who were involved in the implementation of the program. The research findings indicate that AISP has had great impact in the district in the sense that maize yields improved by a record 529% among households; maize production is profitable with a gross margin ranging from 158,746 to 424,800 RWF per hectare; and households were able to meet their cash needs for consumption and investment from maize sales. It is also evident that addressing marketing constraints will boost the impact of this program further. We therefore conclude that AISP achieved most of the objectives stipulated under its mandate. If up-scaled to other districts of the country, this program is capable of bringing about a local green revolution in agriculture in the country.
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1. Introduction

1. Introduction

Agriculture is the backbone of Rwanda's economic activity. As put forward by Clay (2008), there is a strong correlation between agricultural growth and economic prosperity. The agricultural sector is employing about 87 % of the working population, producing about 46% of the GDP and generating about 80% of the total rural household revenues. In order to achieve the objectives of the agricultural sector, as formulated in the Vision 2020 and in the PRSP, the Government of Rwanda has adopted the agricultural policy whose main goal is to contribute to the national economic growth, improved food security and increase the incomes of the rural households (NISR, 2010).

Agriculture is explicitly recognized in the economic development and poverty reduction strategy (DPRS) as being one of the four priority sectors of the economy that will both stimulate economic expansion and make the greatest contribution to poverty reduction the other sectors being health, education and road maintenance. The overriding policy objective for agricultural sector is for rural household incomes to be increased in a sustainable manner and for the sources of income to be diversified while at the same time, food security is to be strengthened. It is forecast that agriculture will contribute 28 percent towards the growth of overall GDP over the five-year period, down from the 33 per cent that the sector contributed between 2003 and 2007 (MINECOFIN, 2009).

However, experts have warned the high probability that domestic agriculture will soon reach its natural limits, which indeed makes new agricultural policy implementation urgently needed. This is the reason why the government has adopted new programmes through which agricultural sector can be promoted. Among the adopted programmes, the recent Crop Intensification Program policy has the aim of boosting agricultural productivity through the use of improved agricultural inputs. This reflects good productivity growth through intensification, and is desirable to continue (IFDC, 2010).

Low agricultural productivity in Rwanda is mainly attributed to low use of inputs. In a vicious cycle, the low productivity continues to prevent farmers from using inputs, as many farmers barely produce sufficient food to feed their family, and therefore have no income with which to purchase yield enhancing inputs. Thus the solution lies in breaking this vicious cycle through appropriate intervention. Green revolution in Asia and elsewhere was mediated by the facilitation of modern inputs for farmers such as improved seeds, fertilizers and pesticides (IFDC, 2010).

Another problem concerns continual cultivation of maize on the same land without addition of organic or inorganic fertilizers which leads to low yields. Low yields then lead to inability to afford the purchase of inputs (Verwimp, 2002). Purchase of inputs on credit is also not possible for most farmers because rural credit markets are underdeveloped and the costs of credit administration are too high. Low volumes of input demand and poor infrastructure and high transport costs lead to high input costs and inhibit the development of input supply systems in less accessible areas. These in turn inhibit the economic growth of small-scale maize producers in Rwanda, especially in Kirehe district.

The conventional argument for subsidies in agricultural development is that their primary role is to promote adoption of new technologies and thus increase agricultural productivity (Ellis, 1992). Agricultural inputs subsidies were also often implemented as part of policies aiming to support agricultural development in more remote areas (IFDC, 2010). This is achieved by allowing farmers to access purchased fertilizers and improved seeds at lower cost. Input subsidies have also been a means for raising farm incomes and when coupled with complementary credit and extension services. This was intended to encourage economically and technically efficient use of agricultural inputs (FAO, 1996).

Input vouchers constitute a flexible market development policy tool that permits voucher holders to purchase specific quantities and types of inputs from trained dealers who agree to accept vouchers as payment; the dealers can then redeem the vouchers from the program organizers with an agreed margin to cover their expenses and agreed level of profit (Fann et *al.,* 2003). The programs include a targeting mechanism, a financing mechanism, and a voucher redemption system with built-in safeguards against fraud; when well-designed, they need to be implemented through normal commercial channels to assist development of private sector market network dealers and rural financial agencies (Dorward et *al.*, 2008).

Agricultural inputs use in Rwanda is therefore essential as the majority of smallholder farmers who are land constrained have poor soils and do not access improved technologies. These inputs are the most important key ingredients needed to boost agricultural productivity and economic growth. Therefore, it is worth to analyze the impact of agricultural input subsidies programme on livelihood of rural small-scale maize producers in the district and also country wide in order to ascertain the efficacy of this noble program.

2. Material and Methods

2.1. Study site description

The District of Kirehe, which has a surface area of 1225, 4 km^2, is located in the south-east of the Republic of Rwanda at 133 km from Kigali capital. It shares the eastern border of Rwanda with Tanzania. The Akagera River constitutes the natural limit between the district and Tanzania. In the South, Kirehe district also borders with Republic of Burundi and Tanzania. In the West, the district shares border with Ngoma District and Kayonza District in the North. Kirehe District has 12 administrative sectors, divided into 60 Cells and 613 villages. In general, the relief of Kirehe district is that of the areas of the low plates. However, there is a mountain chain which divides the area into two geographical entities, characterized by a plain of low altitude of more or less than 1350m of altitude, punctuated by insulated hills and those of the hills and mountains with plates at the tops (Mahama Mount and a mountain chain of Imingongo and Gatwe). The average altitude of Kirehe District is 1500m. The district is located in a semi-arid zone with temperatures typically in the range of 20-24 °C, with maximum reaching 26-29 °C. There are alternating dry and rainy seasons during the year, with a short dry season from January until mid-March, a long rainy season from mid-March until mid-June, a long dry season from mid-June until mid-October, and a short rainy season from mid-October until the end of the year. Rainfall can be highly irregular, with an annual average of 800-900 mm.

The tropical soils are more widespread in the district. The common soils are the Kaolisoils, the xérokaolisols and the grounds of the valleys especially the vertisols and the histsoils. Combined at a lenient time, all these soils can be exploited and give a satisfactory production. Concurrently to these soils, considered good for the culture, there are also sandy soils favorable to construction, found in the area of Bukora, of Nyamugali Sector. The soils are of good quality and suitable for cultivation, but declining soil fertility and erosion are affecting agricultural productivity, while land scarcity prompts people to cultivate on steep slopes. According to statistical data, Kirehe District population is 292,215 inhabitants on surface area of 1225.4 sq km. The population density is 238.5 people per km^2. The population growth rate for the district is estimated to be 2.9% per annum, and about 63% of the population is below 35 years of age (DDP Kirehe, 2007). Table 1 below shows the distribution of the population across all sectors.

Table 1: Number of the households and population size of Kirehe district by sector in 2007

Sector	Households	Male-Headed Households	Female-Headed Households	Total population
Gahara	5 584	4 057	1 527	29040
Gatore	5 132	3 635	1 497	22412
Kigarama	5 028	3 599	1 429	26783
Kigina	3 996	2 916	1 080	21140
Kirehe	4 049	2 908	1 141	20424
Mahama	3 737	2 798	939	22162
Mpanga	5 275	3 774	1 501	29619
Musaza	4 394	3 191	1 203	23647
Mushikiri	4 671	3 243	1 428	25531
Nasho	4 571	3 343	1 228	26060
Nyamugari	5 148	3 761	1 387	26479
Nyarubuye	3 820	2 773	1 047	18918
Total	55 405 100%	39 998 (72%)	15 407 (28%)	292,215

2.2. **Overview of the main characteristics of economic development**

The economy of Kirehe District is based primarily on the Primary sector and in particular on agriculture and livestock keeping. The Secondary and tertiary sectors are little developed or even non-existent. The economy of Kirehe District is largely agricultural: 31% of the households rely exclusively on agriculture and don't have any livestock, 4% are exclusively engaged in animal production, while 35% have mixed farming systems including crop production and some livestock. Only 3% of the rural population gets their income from non-agricultural activities.

Agricultural production is mostly for subsistence, principal crops include banana, beans, maize, cassava, sweet potato, sorghum, vegetables, rice and fruits, with banana, maize, beans and rice as important marketable crops. Banana is the major staple food and represents 63% of the total food production in the district. Only 3% of farmers in the district are engaged in mainly market oriented production, while some 35% of farmers regularly have a surplus for sale (DDP Kirehe, 2007).

2.3. Sample size determination

The formula below was used to calculate the sample size as:

$$n = \frac{z^2 pqN}{e^2(N-1)+z^2 pq}$$ (Kothari, 2004)

Where: n: is the sample size for a finite population

N: size of population which is the number of households

p: population reliability (or frequency estimated for a sample of size n), where p is 0.5 which is taken for all developing countries population and p + q= 1

e: margin of error considered is 10% for this study.

$Z_{\alpha/2}$: normal reduced variable at 0.05 level of significance z is 1.96

According to the above formula, the sample size for all three sectors is:

$$n = \frac{(1.96)^2 \times 0.5 \times 0.5 \times 9854}{(0.1)^2(9854-1)+[(1.96)^2 \times 0.5 \times 0.5]} = 96$$

So we have 96 households as a sample

Formula used for sample size at sector level

Formula used for sample size at sector level is:

$$n(Sector) = \frac{N(Sector) \times n(all\ Sectors)}{N(all\ Sectors)}$$

(Kothari, 2004)

where: n(Sector): is the sample size at sector level

N(sector): is the household number of a sector

n(all sectors): is the sample size of all three sectors

N(all Sectors): is the household number of three sectors through which the survey was conducted

According to the formula, the sample size for the three sectors is:

$$n(\text{Nyamugali}) = \frac{3332 \times 96}{9854} = 32.4 \approx 32$$

$$n(\text{Mahama}) = \frac{2828 \times 96}{9854} = 27.5 \approx 28$$

$$n(\text{Mpanga}) = \frac{3694 \times 96}{9854} = 35.9 \approx 36$$

2.4. Sampling Procedure

It is sometimes cheaper to determine the sample in some way for example: by selecting respondents from certain areas only, or certain time-periods only. For the present study, we chose a sample of three sectors namely Nyamugali, Mahama and Mpanga. These sectors were considered because they are characterized as the most maize producing sectors and farmers in these sectors participated in Agricultural Input Voucher Programme (AISP).

In the second stage, a sample of respondents within selected sectors was obtained. Based on the data which consists of the farmers who received the agricultural input through the Agricultural Input Subsidies Programme, the distribution of households in sectors was as followings: 3,332 households in Nyamugali, 2,828 households in Mahama and 3,694 households in Mpanga. 9,854 is the total number of households in three sectors chosen for this study (ENAS, 2011).

2.5. Interviews

According to the formula of sample size determination developed by Kothari (2004), the researcher found that only 96 small-maize producers would answer questionnaires in all three sectors. By using the formula of proportional allocation, and according to each sector weight in terms of its households involved in Agricultural Input Subsidies Programme through voucher system, the samples are 32 households in Nyamugali, 28 households in Mahama, 36 households in Mpanga sector. The farmers to answer questionnaires on cell level were chosen at random.

2.6. Data analysis

The Statistical Packages for Social Science (SPSS, version 12 and 13) and Excel were used to analyze data achieving both descriptive and inferential statistics; secondary data were used in the light of its relevance to the present research. The statistical analyses used concern: Freedman test for first hypothesis, linear regression equation was used for the second hypothesis. For the third hypothesis we used paired sample t-test and for the last hypothesis we used double log functional model.

2.6.1. Linear regression model applied

Linear regression is a technique for analyzing problems in which there are one or more independent variables that determine an outcome. The outcome is measured with a dichotomous variable (in which there are only two possible outcomes). The goal of Linear regression is to find the best fitting (yet biologically reasonable) model to describe the relationship between the dichotomous characteristic of interest (dependent variable = response or outcome variable) and a set of independent (predictor or explanatory) variables. Linear regression generates the coefficients (and its standard errors and significance levels) of a formula to predict a logit transformation of the probability of presence of the characteristic of interest.

The regression equation was used to identify all factors affecting use and adoption of agricultural input for maize production in livelihood of Kirehe District. The formula is shown as:

$Y = \beta 0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 \ldots\ldots + \beta i x i + Ui$ (Dominick, 1971).

Where: Y: adoption of agricultural input use, $\beta 0$: Constant, βi: Regression coefficient, xi: Independent variables (x_1, x_2, $x_3 \ldots xn$) and Ui: Error terms.

The independent variables included in the model were: gender of household head, age of household head, civil status, size of household, education level, extension service, and availability of credit, labor, and cattle owned type of ownership of land and size of landholding among sampled farmers.

3. Results

3.1. Demographic characteristics of households

Demographic characteristics play a key role in determining the livelihoods of rural people. Those demographic characteristics are important because they help to enumerate the sample but also they can influence positively or negatively on the adoption of new technologies in maize production for smallholder farmers. In this study, demographic characteristics considered in the survey include gender of household head, age of household head, civil status, size of household, education level, extension service, availability of credit and labor among sampled farmers.

3.2. Gender distribution of heads of households

The table below indicates gender distribution in the sample size which was taken in three sectors (Nyamugali, Mahama, and Mpanga).

Table 2: Gender distribution

Sector	Male	Female	Total
Nyamugali	19	13	32
Mahama	17	11	28
Mpanga	21	15	36
Total	57	39	96
Percentage %	59.4%	40.6%	100%

The gender distribution shows that 57 out of 96 (59.4%) interviewed farmers are male, 39 of 96 (40.6 %) are female. This means that most of the head of household in Kirehe are men. Firstly, this depends on Rwandan culture which is a predominantly patriarchal society (men are household heads). Secondly, in this district, the men are more involved in agricultural activities than women.

3.3. Age categories of heads of households

The table below indicates age distribution in the sample size which was taken in three sectors (Nyamugali, Mahama, and Mpanga).

Table 3: Age of household head

Age range of respondent	Percentage (%) of age range of farmers in three sectors			
	Nyamugali	Mahama	Mpanga	Total
<35	14.6	7.3	12.5	34.4
36-45	8.3	8.3	6.3	22.9
46-55	8.3	7.3	11.5	27.1
>55	2.1	6.3	7.2	15.6
Total	33.3%	29.2%	37.5%	100%

Mean: 42.98, standard deviation: 11.45

The table above shows that age distribution of household head is 42.98 ± 11.45. This means that the population is made by economically active people because the youngest is aged 31.53 and the eldest should be 54.43. The middle age is 42.98 years.

3.4. Household educational level distribution of sampled farmers

The table 4 presents the completed educational level distribution in the sample size which was taken from three sectors (Nyamugali, Mahama, and Mpanga).

Table 4: Education level of farmers

Sector of household head	Educational level				
	Never attended	Primary	Vocational	Secondary	University
Nyamugali	3	26	2	0	1
Mahama	2	22	2	2	0
Mpanga	4	30	1	1	0
Total	9	78	5	3	1
%	9.4	81.2	5.2	3.1	1.1

Table 4 shows that 9 out of 96 (9.4%) interviewed household heads have never attended school, 78 out of 96 (81.3%) completed the primary studies, 5 out of 96 (5.2%) completed vocational studies and 3 out of 96 (3.1%) finished the secondary school. Only 1 out of 96 (1.0%) finished the tertiary level. It is highlighted that most of the household heads interviewed in three sectors of Kirehe district completed primary school. Education level influences the behavior of people on adoption and use of new Agricultural input for maize production. Gervais (2001) states that highly educated farmers may acquire more easily technical information as their capacity to digest information from various sources is larger than non educated farmers.

Indeed educated farmers do read technical bulletins and innovative-describing leaflets more than do their less educated counterparts presumably because they find it profitable to do so. The more people are educated the more they are aware of these technologies because they play a great important role in increase of agricultural production, thereby increasing food security stability and ensure sustainable income generation.

3.5. Livestock Assets Distribution

Table 8 below indicates the livestock ownership distribution in the sample of three sectors

Table 5: Livestock Ownership distribution

Species of livestock	Number of livestock owned			
	None	1-5	6-10	More than 10
Cattle	16	55	17	8
Goat	30	44	12	10
Sheep	90	5	1	0
Pigs	74	13	9	0
Poultry	34	32	15	15
Rabbits	88	6	2	0

The results presented in the Table 5 above show that only 16 out of 96 (16.7%) don't have any cattle, 80 out of 96 (83.3%) have more than one cow, 30 out of 96 (31.3%) interviewed farmers have no goats and only 66 out of 96 (68.7%) have more than one goat. 90 out of 96 (93.8%) don't have any sheep only 6 out of 96 (6.2%) have more than one sheep, 74 out of 96 (77.1%) don't have any pigs only 22 out of 96 (22.9%) have more than one pig, 34 out of 96 (35.1%) don't have any poultry only 62 out of 96 (64.9%) have more than one poultry and 88 out of 96 (91.7%) don't have any rabbits, 8 out of 96 (8.3%) have more than one rabbits. Those results have positive impact on rural people livelihood because more farmers in rural area have many livestock more they have to gain the income from the sell and resources found are used in the daily living conditions.

3.6. Awareness about Agricultural Input Subsidies Programme

The table below indicates the distribution of information about Agricultural input subsidies programme in the sample size which was taken in three sectors (Nyamugali, Mahama, and Mpanga).

Table 6: Source of Information about AISP

Sector of respondent	Source of information concerning AISP			
	Local Authorities	Agronomists	Opinion Leaders	Service Providers
Nyamugali	14	11	2	5
Mahama	12	9	2	5
Mpanga	15	13	2	6
Total	41	33	6	16
Percentage	42.6	34.4	6.3	16.7

The table above indicates that 41 out of 96 (48.7%) got information about this programme through local authorities, 33 out of 96 (33.4%) by Agronomists of sectors, then 6 of 96 (6.3%) by opinion leaders and finally 16 of 96 (16.7%) farmers received information through service providers. All farmers who answered the questionnaires confirm that they know voucher (Nkunganire) and they have used this type of voucher for reception of Agricultural Inputs under AISP.

3.7. Voucher adoption rates among farmers

Table 7 indicates the percentage of sampled farmers in all three sectors which are Nyamugali, Mahama, and Mpanga who used vouchers from 2007 to 2011.

Table 7: Percentage of farmers who used vouchers from 2007 to 2011

Sector of respondent	Year of joining this programme (% of respondents)				
	2007	2008	2009	2010	2011
Nyamugali	14.6	12.5	5.2	1.0	0.0
Mahama	16.7	5.2	4.2	2.1	1.0
Mpanga	22.9	9.4	3.1	1.0	1.0
Total	54.2	27.1	12.5	4.2	2.0

The percentage of farmers adopting voucher use in AISP from 2007 and 2011 varied significantly across sectors, but the results show that the average was 54.2% in 2007, 27.1% in 2008, 12.5% in 2009, 4.2% in 2010 and 2% in 2011. The results from tables show that the number of farmers decreases substantially over the years.

3.8. Satisfaction of farmers about AISP

According to figure 1, 22.9% of sampled farmers are very satisfied with the programme, 62.5% are satisfied, 12.5% present a fair attitude, 2.1% are dissatisfied. None of the respondents expressed feelings of being very dissatisfied. The most problems are related to the process by which agricultural inputs are distributed later according to the appropriate time of use, the disasters caused by climatic change and the manner by which the redeeming of subsidized agricultural input is done.

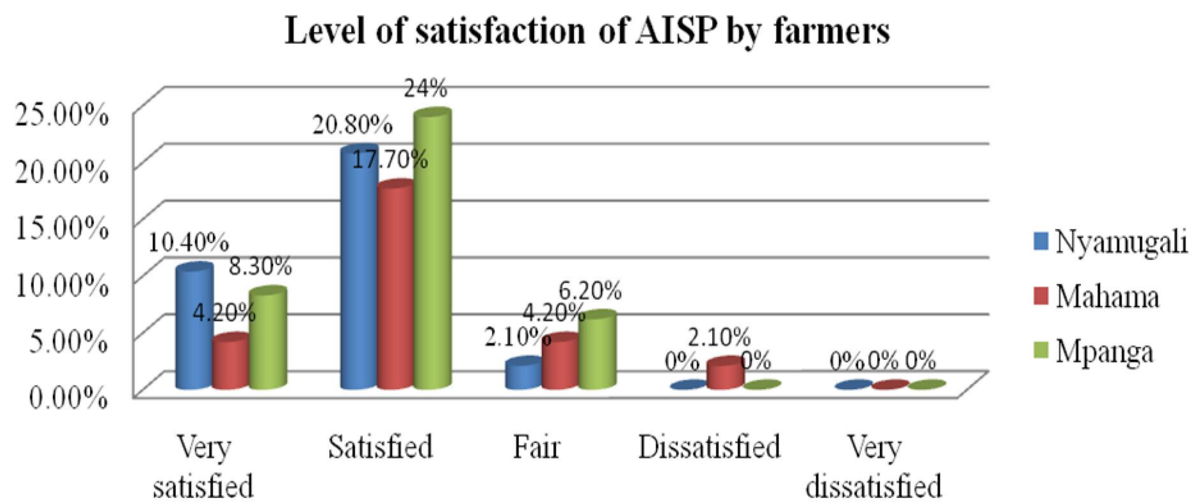

Figure 1: Level of satisfaction of farmers toward AISP

3.9. Constraints encountered by farmers under AISP in the voucher system

There are many constraints encountered by farmers as shown in the table below.

Table 8: Constraints faced by farmers under AISP implementation

Sector of respondent	Constraints faced by farmers who are involved in AISP (% of respondents)					
	Lack of modern techniques	Timing of AISP availability	Fraud of AISP	Voucher redeeming	Climate change	Other constraints
Nyamugali	31.3	16.7	7.3	4.2	28.1	3.1
Mahama	29.2	13.5	4.2	17.7	29.2	0.0
Mpanga	33	20.8	6.3	16.7	32.3	2.1
Total	93.5	51	17.8	38.6	89.6	5.2

Table 8 shows that lack of modern techniques is a predominant constraint with 93.5% and climatic change comes the second with 89.9%. This means, for example, that if there is climate change caused by lack of rain happens, total losses can occur to the farmers. Then respectively follow timing of AI availability, voucher redeeming and fraud of AI with 51%, 38.6% and 17.8%. "Other constraints" is the last with 5.2% of respondents responding yes.

3.10. Status of money saving among sampled farmers before and after AISP

Figure 2 shows that there is an improvement of farmers who participated in saving activity from 28.1% of farmers before AISP to 86.6% after AISP. Then, the number of farmers who did not participate in saving and credit was reduced from 68.7% farmers to 13.4 %. Access to financial resources for farmers can help them to purchase agricultural inputs easily and improve production. Then, a big number from the farmers is using only financial group organization known as *Ibimina*. The farmers also are encouraged to join local financial institutions like MFIs and *Umurenge* Sacco in order to improve their agricultural activities in quantity and quality.

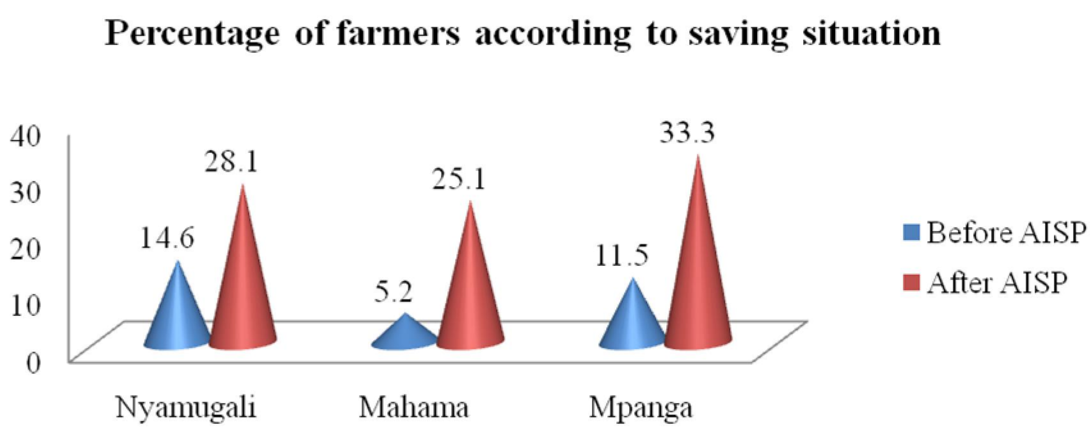

Figure 2: Saving situation among sampled farmers

3.11. Impact of AISP on social inclusion

Members of a community rely on a network of social relationships that provide safety nets to their livelihoods. Usually, farmers rely on relatives to survive in rural areas through adoption of new technologies for agricultural transformation and in farming communities. Membership in community associations offers tremendous opportunities to boost agricultural production by providing various forms of support to farmers.

Table 9: Membership of sampled farmers into community associations

Sectors	Types of social activities (% of respondents)									
	Before AISP					After AISP				
	Association and Cooperative	Ikibina	Ingobyi	Dusasirane	Others	Association and cooperative	Ikibina	Ingobyi	Dusasirane	Others
Nyamugali	26.1	22.9	10.8	0.0	0.0	32.3	28.1	32.3	12.2	1.1
Mahama	19.8	26.0	21.9	7.3	1.0	26.0	30.2	30.0	8.5	1.0
Mpanga	22.9	30.3	18.5	8.3	0.0	36.5	26.0	36.5	10.3	2.1
Total	68.8	79.2	51.2	15.6	1.0	94.8	84.4	98.8	31.0	4.2

The results from the table 16 on the next page, show that membership of sampled farmers in Associations and cooperatives is from 68.8% before to 94.8% after AISP, for Ibimina is 79.2% before to 84.4 % after this programme, Ingobyi represents 51.1% before to 98.8% after AISP, Dusasirane represents 15.6% before to 31% after AISP and other forms of social activities account 1.0% before AISP to 4.2% after AISP. The sampled farmers pointed out that they belong to diverse community associations. Some farmers belong only to one association while others belong to more than one association.

Table 10: Income per hectare gained from maize production under AISP

	N	Minimum	Maximum	Mean	Std. Deviation
Gross income/ha	96	52,500.00	630,000.00	246,400.00	124,168.7641
Total cost	96	13,375.00	161,375.00	87,653.90	24,106.2560
Gross margin	96	32,100.00	424,800.00	158,746.10	83,070.3383

According to the results from the table 10, the average income gained per hectare is 246,400 Rwf while the total cost is 87,653.90 Rwf. The gross margin is 158,746 Rwf per season of maize production which is profit for rural people without taking any consideration about other production systems and selling issues. It means that maize production under AISP can generate income specifically income for the poor in rural area.

3.12. Use of maize income in needs satisfaction

The income gained from maize is used to satisfy some needs among sampled farmers. The table 23 indicates the results from the field in three sectors which are Nyamugali, Mahama and Mpanga according to the level of satisfaction.

Table 11: Level of needs satisfaction (%) of farmers by maize income

Satisfied Needs	Percentage (%) of the level of needs satisfaction of farmers by maize income									
	Before AISP					After AISP				
	Very high	High	Satisfied	Low	Very Low	Very high	High	Satisfied	Low	Very Low
Food	13.5	30.2	39.6	11.5	5.2	28.1	43.8	24.0	3.1	1.0
Health insurance	9.4	26.0	19.8	25.0	19.8	18.8	38.5	20.7	12.7	9.4
School fees	14.6	29.2	13.5	32.3	10.4	11.5	26.0	35.4	19.8	7.3
Housing	5.2	14.6	30.2	34.4	15.6	2.1	14.6	49.6	27.5	6.3
Home equipment	4.2	15.6	25.0	35.4	19.8	8.3	27.1	31.3	27.1	6.3
AI redeeming	0	0	0	0	0	15.6	33.3	38.5	8.3	4.2
Average	7.8	19.3	21.4	23.1	11.8	13.5	31.7	30.9	17.6	6.3

As for the results from the table 11 above the average of satisfaction of different needs among sampled farmers is increasing for very high satisfaction, high satisfaction and satisfaction from "before AISP" to "after AISP". For low satisfaction and very low satisfaction the average of satisfaction is decreasing. This allows us to confirm that this programme has a positive impact on satisfaction of different needs of sampled farmers.

3.13. Availability of credit for farming activities

The table below represents the percentage of farmers who have access to credits for farming activities in sampled respondent in three sectors which are Nyamugali, Mahama and Mpanga.

Table 12: Percentage of farmers according to credit access

Sector of respondent	Percentage of farmers with credit access			
	Before AISP		After AISP	
	Yes	No	Yes	No
Nyamugali	1.0	32.3	4.2	29.1
Mahama	0.0	29.2	2.1	27.1
Mpanga	1.1	36.5	3.1	34.4
Total	2.1	97.9	9.4	90.6

The table 12 shows that only 2.1% among sampled farmers accessed credit before AISP and the percentage of access increased to 9.4% after AISP. According to this table, the percentage of maize producers who adopted the use of financial institutions in accessing credit was increasing slowly because it was 2.1% before AISP and 9.4% after AISP. This is due to fact that farmers were encouraged to join local financial institutions like MFIs and Umurenge (sector) SACCOs which were initiated by the government and operate at sector level.

3.14. Constraints to maize production

Maize production in sampled farmers' area is constrained by several factors and the constraints that they face are presented in the table 25 below.

Table 13: Distribution of farmers according to faced constraints in maize production

Sector of respondent	Constraints faced by farmers in maize production (% of respondents)						
	Pests and diseases	Peak labor in farming system	Weed infestation	Climatic disasters	Competition with other crops	Marketing constraints	Others
Nyamugali	6.3	18.8	9.4	31.3	19.8	13.5	4.2
Mahama	0	15.6	6.3	27.1	21.9	9.4	2.1
Mpanga	5.2	19.8	7.3	32.3	24	17.7	3.1
Total	11.5	54.2	23	90.7	65.7	40.6	9.4

Table 13 reveals that climatic disasters are the major problem with 90.7% in the area under study. This is followed by competition with other crops with 65.7%, peak labor in farming system follows with 54.2% and market constraints come with 40.6%. Weed infestation has 23 %, pests and diseases present (11.5%) and other constraints are the least with 9.4%. This reveals that farmers in the area under study are faced with constraints that can limit maize production.

3.15. Constraints to maize selling among sampled farmers

The table below indicates the different constraints encountered by farmers on maize selling in the sample size which taken in three sectors (Nyamugali, Mahama and Mpanga).

Table 14: Constraints faced by farmers in maize selling

Sector of respondent	Constraints faced by farmers in maize production selling (% of respondents)						
	Price instability	Lack of adequate storage	Post-harvest handling	Poor quality	Poorly coordinated market structure	Low yields	Others
Nyamugali	24.0	28.1	29.2	4.2	22.9	6.3	4.2
Mahama	21.9	24.0	25.0	2.1	21.9	3.1	2.1
Mpanga	26.0	26.0	30.2	2.1	28.0	8.3	0.0
Total	71.9	78.1	84.4	8.4	72.9	17.7	6.3

According to the results from table 14, the lack of post-harvest handling technologies count for 84.4%, lack of adequate storage has 78.1%, poorly coordinated market structure has 72.9 %, price instability has 71.9%, low yield comes with 17.7%, then poor quality flows with 8.4% and finally other constraints present 6.3%. In the area under study, producers usually sell maize in an unprocessed form and in various quantities. No farm level drying facilities exist. As a result, the moisture content of sun dried maize varies considerably depending upon local weather conditions and the period of storage.

3.15. Test of hypotheses

In this study, we tested four hypotheses: agricultural inputs received by farmers, household heads with education are more likely to use inputs successfully, use of agricultural inputs has a positive outcome on maize production and AISP had a positive impact on profitability of maize production in the study site. The test statistic result is presented in Table 15.

Hypothesis 1: Among agricultural inputs distributed in Kirehe district under AISP, fertilizers are the most important.

Table 15: The most common agricultural inputs distributed in Kirehe district

Variables	Mean Rank
Fertilizers	1.70
Pesticides	4.70
Maize Seeds	1.70
Cassava Seeds	3.51
Labors	4.70
Other AI	4.70

The results in Table 15 about common agricultural input distributed under AISP show us that the smallest mean rank is 1.70 corresponds to fertilizers and maize seeds. This means that the most important received Agricultural inputs by sampled farmers under AISP are fertilizers and seeds of maize. This coincides with the reality on maize production in Kirehe district because farmers received subsidized fertilizer through voucher system. According to the result of statistical analysis the highest rank is 4.70 which corresponds to pesticides, labor, and other agricultural inputs. As for results from analysis, we have confirmed our hypothesis because fertilizers are among agricultural inputs distributed in Kirehe district and rank the smallest mean of 1.70.

Hypothesis 2: Heads of households who are educated are more likely to use successfully agricultural input subsidies for maize production

Table 16 indicates the results of statistical analysis on independent variables influencing the adoption of fertilizer more than others for households in the area under study.

Using Linear regression equation, the test gives us different levels of significance comparatively to level of significance at 0.05 (5%).

Table 16: Factors affecting fertilizer use among sampled farmers

Variables	B coefficients	Std. Error	Sig.
Constant	1.139	1.602	0.479
Gender	-0.049	0.197	0.805
Age	0.009	0.011	0.040
Civil status	-0.044	0.157	0.780
Size of household	0.064	0.050	0.021
Education level	0.001	0.188	0.996
Extension service	0.149	0.234	0.032
Availability of credit	-0.117	0.504	0.087
Labor	0.252	0.135	0.046
Cattle owned	-0.048	0.125	0.705
Type of ownership of land	0.055	0.078	0.048
Size of landholding	-0.142	0.125	0.025

Results from Table 16 allow us to formulate that adoption of fertilizers (Y) = 1.139 - 0.049 Gender + 0.009 Age -0.044 civil status + 0.064 Household size + 0.001 Education + 0.149 extension services – 0.117 availability of credit + 0.252 labor – 0.048 cattle owned + 0.055 types of land ownership – 0.142 size of landholding+U_i (Formulated model).

Then, coefficient of determination (R^2) is equal to 0.711 which means that these factors influence the total variation in adoption of fertilizer use are at the level of 71.1%. The remaining 28.9% is attributed to factors included in the error term. The results of the analysis show us that the variables which have statistical influence on adoption of fertilizer use in maize production at the level of significance less than 0.05 are age of the farmer, size of household, extension services, labor, size of land holding and type of ownship of land. These factors statistically influence the use of fertilizer in maize production because their levels of significance are less than 0.05. The hypothesis was rejected because the level of significance of education is 0.996 which is higher than 0.05 the level of test. It is concluded that the level of education of the Head of household doesn't influence statistically the level of adoption of fertilizer use in small-scale maize producers in Kirehe district. But adoption is influenced by other factors which are highlighted above.

Hypothesis 3: The use of agricultural input through AISP has a positive impact on increase of maize production among small-scale maize producers

In order to test hypothesis 3, we used all impact assessment of the adoption of Agricultural input subsidies programme on the production of maize in Nyamugali, Mahama and Mpanga sectors of Kirehe district. The adequate test was the paired- sample test.

Table 17: Paired samples statistics of maize production/Kg/ha before and after AISP

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Maize production per Kg/ha before AISP	280.1146	96	193.5970	19.7589
	Maize production per Kg/ha after AISP	1760.0000	96	886.9197	98.5208

Table 18: Paired sampled test of compared maize production/kg/ha before and after AISP

	95% confidence level of paired Differences					
	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Compared maize production per Kg/ha before and after AISP	-1479.8854	772.25105	78.81754	-18.776	95	.000

According to table 17, we reject Ho and we accept H_1. We conclude that there is statistically significant difference between the quantity of maize produced per hectare before and after AISP implementation. The maize production increased from 280.11 kg before AISP to 1760.0 kg after AISP.

Hypothesis 4: The AISP has a positive impact on profitability of maize production of small-scale maize producers in Kirehe district

Another important determinant factor of agricultural technology adoption is the expected profitability of that technology for users.

Table 19: Result of double log function analysis for maize production

Variables	Regression Coefficients	Standard error	T-values
Constants	1.44969	0.55658	1.49607
Fertilizer(kg/ha)	0.006	0.00045	1.1260
Labour (Man/ha)	0.015	0.00113	3.0700
Seed(Kg/ha)	0.011	0.00085	13.0700
Pesticides (lit/ha)	0.078	0.06207	1.2640

Table 20: Estimated resource-use efficiency for maize production

Resource input	MVP	MFC	Efficiency ratio (r)
Fertilizer(kg/ha)	0.138	46	0.003
Labor (Man/ha)	0.472	283	0.002
Seed(Kg/ha)	0.142	0.00	0.00
Chemical (lit/ha)	528	4,752	0.111

Table 19 shows that the result of the double log functional form has the best fit to the data. All the variables in the model have positive regression coefficients indicating direct relationship between the inputs and maize output. The coefficient of multiple determinations (R^2) is 0.73 which implies that 73% of the variation in the output of maize is accounted for the variable inputs in the model. This indicates that an increase in each of them will result to an increase in the output of maize. All inputs, however, only fertilizer, agro-chemicals, and labor were statistically significant at 5 percent level.

3.16. Resource use efficiency

The estimated coefficients were used to compute the MVP and its ratio (r) with MFC used to determine the economic efficiency of resource used.

According to the Table 20 above, the study revealed that maize farmers in the area under study did not achieve absolute efficiency in the use of variable inputs. However, the study showed that maize production among farmers was profitable, but not maximized due to certain inefficiencies in the use of some variable inputs.

4. Conclusion

1. It was found that under Agricultural Input Subsidies Programme (AISP), the government of Rwanda supplied agricultural inputs (fertilizers, seeds of maize and cuttings of cassava) and distributed them to farmers at subsidized prices at a rate of 50% in maize production in Kirehe district. The Friedman test, showed that fertilizers and maize were ranked as the most important inputs distributed using voucher system and both had 1.70. Other inputs rank more than 1.70: cassava cuttings are ranked at 3.51; both pesticides and labor are ranked at 4.70. We concluded that fertilizer is the most agricultural input distributed in Kirehe district under AISP and we confirm our hypothesis number one.

2. The results of regression analysis showed that the variables which have statistical influence on adoption of fertilizer use in maize production at the level of significance of 0.05 are size of household (0.021), size of landholding (0.025), extension services (0.032), age of the farmer (0.040), labor (0.046) and type of ownship of land (0.048). These factors statistically influence use of fertilizer in maize production because their levels of significance are less than 0.05. The degree of influence of these factors are ranked as the following: the first influencing factor is "size of household", the second is "size of landholding", the third factor is "extension services" the fourth is "age" and the last influencing factor is "labor". According to these results, it was concluded that the level of education of the Head of household doesn't influence statistically the level of adoption of fertilizer use among small-scale maize producers in Kirehe district because the level of significance of education is 0.996 which is higher than 0.05.

3. The programme of agricultural input subsidies has played an important role in successful implementation of agricultural transformation and the overall development of agriculture sector in the area under study. The reduced (subsidized) prices of these inputs have significantly increased maize production because the output of maize increased from 280.11 kg before AISP to 1760.0 kg after AISP. The income also increased from 39,215.40 Rwf before AISP to 158,746.10 Rwf after AISP. It was concluded that these agricultural inputs subsidies have greatest potential in contributing to wider growth when applied to production of maize and have a key contribution to producers' welfare. The study revealed that small-scale maize producers in the area under study did not achieve absolute efficiency in the use of variable inputs. However, the study showed that maize production among farmers was profitable,

but not maximized due to certain inefficiencies in the use of some variable inputs.

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