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RESEARCH ARTICLE

FACTORS INFLUENCING ADOPTION OF MONEY MARKER PUMP TECHNOLOGY AND ITS IMPACTS ON HOUSEHOLD FOOD SECURITY STATUS IN BONDO-SUB COUNTY-KENYA

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ABSTRACT

Food insecurity remains a major challenge in the marginal areas of Western Kenya which is mainly inhabited by the small holder farmers due to unpredictable rainfall patterns and frequent droughts. The money maker pump technology was launched in October 1998 in response to a demand by farmers for a pump that can push water uphill as well as simply pulling it up from the source. The mission was to lift millions of people in Africa out of food insecurity in a quick, cost-effective and sustainable manner. In Bondo-Sub-county- Kenya, this technology aimed to improve farm output, increase income and consequently reduce household food insecurity among the small holder farming community. The aim of this study was to identify some of the factors influencing the adoption of this irrigation technology in the marginal areas of Bondo-sub County. The Heckman two-stage and the ordinary least square procedures were used to identify these factors and their impact on household food security among the studied farming community. Farm and household level data were obtained from 110 farmers consisting of 52 adopters and 58 non-adopters. The results indicated that availability of labour and increase in number of extension visits to the farm per year increased the probability of adoption. It was also apparent that increase in irrigated area within the farm household resulted in more food availability. In general increase in irrigated area exhibited the highest impact on household food security status while household size had the lowest impact. The study concluded that increasing the area cultivated under irrigation was likely to reduce household food insecurity in Bondo sub county and similar areas across the globe.

INTRODUCTION

In many parts of Kenya, hunger continues to be widespread and the right of everyone to adequate food supply is extensively violated (MOA, 2012). In order to adequately address the widespread food insecurity and poverty agenda in Kenya, the Millennium Development Goals (MDGs) were launched in 2002 with its first goal aiming at halving extreme poverty and hunger by 2015 (Migotto *et al,* 2005). The effect of global climate change has led to the occurrence of erratic rainfall creating uncertainty and unsustainability for agricultural production. Bondo Sub-county located at an altitude of between 1140-1400 meters above sea level within the shores of Lake Victoria is hot with temperatures of 26 – 34 degrees centigrade, night temperatures of about 22 degrees centigrade and experiences frequent droughts. This region receives between 250 and 750 mm of rainfall per annum which is poorly distributed and has only 60% reliability (Jaetzold and Schimdt, 1983) and therefore emphasizes the need for irrigation. Besides most small holder farms are barely 5 Metres from the lake shore. Irrigation farming remains a possible and sustainable means of solving the food insecurity menace in such regions. The traditional irrigation methods used in the area comprises the constructions of furrows, use of buckets to lift and distribute water from the lake, shallow open wells or watering cans to lift water from streams. Although the low capital requirements of these traditional technologies makes them advantageous and affordable, their low delivery capacity and labour intensive nature make them highly unfavourable to the local production conditions (MOWI, 2012). Improved water lifting technologies, with relatively high efficiencies such as motorized pumps, have been tried but have been found to be favourable mostly to large-scale farmers who are the minority among the farming community. For small-scale farmers, who usually irrigate relatively small pieces of land and have capital limitation, such technologies are unaffordable. Therefore the lack of simple, affordable and easily adaptable irrigation technologies, suitable to the production conditions and needs of small-scale farmers in Bondo Sub-county, among others, is a serious handicap to efforts for achieving household food security in the study area.

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Today a substantial variety of low-cost, affordable irrigation technologies options available, include; drip and money maker pumps. However the money maker pump technology is more appealing to the small-holder farmers due to its ease of maintenance, its low operation cost, no fuel requirement and only requires limited repair and maintenance costs. Additionally the pump is fabricated entirely from locally-available materials and can be manufactured using welding equipment and simple hand tools in the metal workshops commonly found locally. The money maker pump was launched in October, 1998 Cote de Vore formerly Ivory Coast, in response to a demand by farmers for a pump that can push water uphill as well as simply pulling it up from the source (MOA, 2012). This means it is suitable for use on steeply sloping land where the water source may be at the bottom. Thousands used it to pump water from hand-dug wells, rivers, streams, lakes, and ponds. It is ideal for sprinkler irrigation, filling overhead water tanks, or for use with nozzles and sprays attached to the end of the delivery hose. The pump can draw water up from 23 feet (7m) and has a total pumping head of 46 feet (14m). Moreover, it can be used to irrigate up to 2 acres of land which within the acreage owned by the small holder farmers in Bondo sub-county hence adequately meeting their irrigation requirements. In Kenya the pump was introduced by an international non-governmental organization, KickStart who recommended its use. In 1991, Martin Fisher and Nick Moon founded ApproTEC, which in 2005 became KickStart. KickStart's early efforts focused on building and processing technologies suited for small holder farmers. Irrigation increases crop yield by 100-400% (FAO, 2012), and most importantly, it enables farmers to produce crops in both dry and off seasons when food supplies dwindle and the market prices are higher (MOA, 2012). Besides it enables movement from subsistence farming to commercial farming hence improving food security and livelihoods. Food security revolve around four pillars namely, food availability, accessibility, nutritional factors and stability of supply (Gloss *et al*, 1999). In order to achieve food security, it requires that the aggregate availability of physical supplies of food is sufficient, that household have access to those food supplies through their own production systems, through the markets or other sources. Irrigation is one of the sure ways of ensuring adequate food supplies when properly practised with adequate knowledge and skills. The money maker pump technology is widely believed to be a pro-poor, poverty alleviating technology due to its demonstrated potential for low cost irrigation, and suitability for small scale farming. The objective this study was to identify the factors that influence the adoption of the money maker pump technology in Bondo Sub County. It also explored the links between the adoption of the money maker irrigation technology and food security status of the household in the study area.

RESEARCH METHODOLOGY

Study area

The study was done in two divisions of Bondo-Sub-county-Kenya between January-December, 2013. The Sub-county has a total area of 1328 km² of which 577.2 km² is land surface, while 751 km² is covered with water of Lake Victoria. Bondo Sub-county lies between 0'26' and 0'90' South of the Equator and from longitude 33'58'E and 34'35'W. The administrative divisions are, Usigu, Maranda and Nyang'oma. It has one constituency known as Bondo. The two divisions were chosen because they are known to have higher number of money maker pump usage for irrigation (MOWI, 2012). Besides, the two divisions are well endowed with river Yala and Lake Victoria. Rain fed agriculture is the most common practice associated with the cultivation of major staples food crops, such as maize, sorghum, millet, beans and vegetables in small acreage. Major economic activities in the area is farming, fishing and small-scale retail trade.

Adopted Research Methodology, Design and Data Analysis

The study was carried out primarily through a survey of 110 farmers comprising 52 adopters and 58 non-adopters of the money maker pump for the period January- December 2013. In obtaining the sample for the survey, a multi-stage sampling technique was used. First, the location in each of the two divisions with more users of money maker pump was sampled using the acreage data obtained from the sub-county agricultural office. In all, five sub-locations were selected in Nyang'oma division and seven in Usigu division. Secondly farmers in each selected sub-locations were stratified into two, namely adopters of money maker irrigation pump and non-adopters. Adopters were identified based on the number of pumps and the farm acreage under irrigation. This was done with the assistance from the agricultural extension field officers. In some cases farmers assisted in identifying other users therefore were also helpful. The non- adopters of the money makers irrigation pump were distributed throughout the selected sub-location. These were farmers who were irrigating using other traditional methods such as bucket, furrow or watering cans. Third, all money maker irrigation pump adopters who were available in the sub-location were interviewed. In addition, those who used the pump before but have stopped were also interviewed. A structured questionnaire was used to obtain the information from the farm household of both adopters and non-adopters. The data collected from the survey was supplemented by interviews with money maker pump promoters and sales agents who provided data on the number of farmers who had purchased the pump. Since the technology adoption is an on-going process, this study was only able to assess the short time impacts of the money maker irrigation pump adoption on household food production in Bondo Sub-county. Data was analyzed using descriptive statistics and the Heckman's two-stage model. The T-test and the chi-square statistic were used to test for significant differences in the socio-economic characteristics of adopters and non-adopters.

Analytical framework

Factors that influence adoption of money maker irrigation pump.

The choice to adopt a particular agricultural technology depends on number of factors (Leyva, *et al*, 2005), these includes farm households asset bundles and socio-economic characteristics, characteristics and cost of technology proposed, perception of need and risk bearing capacity of the household. An asset bundle comprises physical, natural, human, social and financial assets. Accordingly this study hypothesized that the following factors would affect money maker irrigation pump adoption in Bondo sub-county:

Physical/natural assets

The area of land under irrigation is expected to affect the adoption decision. Farmers with less than a hectare of irrigated farm are expected to be willing to adopt the technology since the area is within the pumps capacity to irrigate. The size of irrigated land cultivated would then depend on the availability and the financial status of the farmer. Reliable access to water throughout the year is also considered as a factor that would influence the adoption of the Money maker pump.

Human assets

The quality and quantity of household labor are expected to affect adoption decisions. The quality of household labor is captured by the capacity to work proxied by the age of farm household head, and the capacity to adopt proxied by the level of education of household head. The quantity of household labour is captured by the household size and the ratio of family members that are not earning an income to those who earn (dependency ratio) and the number of household members who can assist in operating the Money maker pump (those of 15 years and above). Money maker pump adoption is expected to have a negative relationship with the age of household head and the dependency ratio; Money maker pump adoption is expected to have a positive relationship with the level of education of household head, household size, and household members above 15 years of age. The gender of the household head is included to examine its impact on adoption decisions, although no negative or positive relationships are hypothesized for this relationship.

Social assets

These are represented by the membership in the farmers' groups or cooperative society and frequency of agricultural extension workers visits to the farm. It is expected that membership in the farming group or cooperative society and high frequency of extension visits will increase adoption decisions. These variables are expected to improve the adequacy of the information obtained about the pump, which will have an impact on the adoption decision.

Financial capacity

This is proxied by farm access to formal or informal credit. Access to credit has remained a constraint to adopting improved technologies in developing countries and is expected that access to credit will affect decision positively. The adoption of Money maker pump technology can be analyzed by employing the logit or probit model. To assist in testing for selectivity bias in the outcome equation, however, the Heckman selection model was used to estimate both the adoption model and the food security impact model (outcome equation). The explanatory variables in the adoption model are age of household head, years of schooling of household head, household size, household members above 15 years, dependency ratio, irrigated land area, membership of farming group, number of agricultural extension worker visits per year, gender, accessibility to credit, reliability of water and region.

Impact on food security status of adopters

In order to further investigate the impact of Money maker pump adoption on the food security status of adopters, a multivariate analysis was done. To isolate the impact of Money maker pump adoption from other intervening factors, the establishment of counterfactual outcome is required, as is the ability to overcome selection bias. According to Heckman and Smith (1999), the establishment of a counterfactual outcome represents what would have happened in the absence of project intervention. Zaini (2000) asserts that these problems become more complicated when participants select themselves into the project. Due to the difficulty of Money maker pump adoption, the identification variable approach following the Heckman two stage procedures was adopted to analyze the data. Selection bias relates to the unobservable factors which may bias the outcome on household food security due to Money maker pump adoption. An appropriate identification variable for this two step procedure needs to be found for the analysis. This variable has to influence adoption but not household food security. Moreover, even if an appropriate identification variable were found, the results from the procedure need to be checked for 'robustness' Zaman (2000). This paper adopted the 'number of agricultural extension workers visits per year' as the identification variable that influences adoption but not household food security. The choice is dictated by the fact that an increase in the number of extension visits increases farmers 'knowledge about the Money maker pump and helps the farmers make an informed decision as to whether or not to adopt. The impact of extension visit on household food production will depend not only on the number of extension visits per year but also on the quality of extension services rendered together with the rate of new technology adoption. The impact of this variable was tested in the adoption and food security models to verify its choice as an identification variable. The Heckman two stage procedure involves, first, the estimation of the adoption process and second, the estimation of the food production outcome. Following Zaman (2000), the adoption equation (the first stage of Heckman model) estimated is:

$$Y_i^* = \sigma + \delta X_i + \mu_i$$

Y_i^* is a latent variable representing the prosperity of a farm household *i* to adopt Money maker pump,

X_i is the vector of farm households' asset endowments, household characteristics and location variable that influence the adoption decision. Prior to analysis, pair wise correlation was conducted for the variables in the model and it was found that some of the variables were highly correlated hence these variables were dropped. Employing the maximum likelihood estimation procedure, the probability of adoption is obtained from the first stage of the Heckman two-step technique. This involves employing a probit regression to predict the probability of adoption. Using these estimates, a variable known as the Mills ratio is obtained as follows:

$$\lambda_i = \frac{\emptyset(\rho + \delta X_i)}{\varphi(\rho + \delta X_i)}$$

Where $\emptyset$ is the density function of a standard normal variable,

φ is the cumulative distribution function of a standard normal distribution and

λ_i is the Mills ratio term

The second stage involves adding the Mills ratio to the food security equation. The factors that determine food security are explicit in the literature and they include household and community characteristics. Lack of household ownership and access to assets that can be put to productive use are important determinants of household food security Ellis and Mdoe, (2003); World bank, (2000). The specific factors identified in the literature that determine household food security include demography or human factors (e.g. household size, age and gender, education and health) and social capital (membership in mutual support organizations); physical (ownership of livestock and other productive assets); community factors (access to infrastructure and services, population density, urban-rural or regional location; and external factors (civil strife, climate) Benin and Mugarura (1999). The household and community characteristics with institutional factors hypothesized to affect household food production are similar to those hypothesized to affect adoption. They are the age of the household head, water availability, the geographical location of the study area and the household Money maker pump adoption status. Food security status of the household is represented by its per capita income by the number of adult equivalent in the household. The household income from irrigated farming, rain fed farming, livestock production, off-farm activities, non-farm activities and remittances.
The food security equation is estimated as:

$$P_i = \beta_0 + \beta_1 W_i + \beta_2 Y_i + \beta_3 \lambda_i + \varepsilon_i$$

Where
E (ε_i) =0

P_i is the capita income of household *i* in US dollars

W_i is a vector of farm households asset endowments, household characteristics and location variable

Y_i is a dummy variable which is 1 adopters and 0 for non-adopters

RESULTS AND DISCUSSION

Socio-Economic Characteristics of Money maker pump Adopters and Non-adopters

The summary statistics of the socio-economic characteristics of adopters and non-adopters of Money maker pump are given in Table 1. It revealed that irrigated farming was male dominated with the percentage of males generally high in the study areas. The result also showed that the age of household head was not significantly different for adopters and non-adopters. Further, there was significant difference in the years of schooling of the household heads among adopters and non-adopters, with the former being more educated. The mean household size of adopters was significantly different at 5% from that of adopters. This implies that the ratio of non-working members to those working is higher in non-adopter households. Therefore, labor availability is lower in these households when compared with those of adopters. Adopters had higher number of agricultural extension visits per year (4.31) than non-adopters (2.07) and the difference at 1%.

Factors that influence Money maker pump adoption

The explanatory variables and summary statistics used in the adoption model are presented in Table 2. Table 3 presents the estimated parameters and the statistically significant variables explaining the adoption decision. Diagnostics statistics (Table 3) showed that the model had a good fit to these variables with chi-square test statistics significant at 1%. This shows that the explanatory variables are relevant in explaining the adoption decision. The signs of the variables also agree with a *priori* expectations, except the variable for age of the household head. The Z test statistics revealed that the dependency ratio, number of extension visits per year, and the regional dummy were statistically significant. Dependency ratio had a negative relationship with the probability of adoption and was significant at 1%. Increase in the number of non-working household members as compared to those working infers lower labor availability for productive economic activities. This apparently discouraged Money maker pump adoption, which requires labor for pedaling. Also, increase in the number of dependants in the household may reduce the household income available for investments, thus discouraging adoption.

The number of extension visits per year was positive and significant at 5% showing that the more frequent the number of visits, the higher the probability of Money maker pump adoption. Table 2: Summary statistics of the explanatory variables The result from the OLS estimation was used to explain the Heckman's model. The p values revealed that four of the variables were statistically significant and affected household food security status Three of these (years of schooling, irrigated area and Money maker pump adoption) had a positive relationship with household food security. (Table 4). The years of schooling of the household head was significant at 1 percent. It expected therefore that the per capita income will increase by 7 percent for each additional year of schooling implying that the education of the household head had an impact on household food security. This is expected because literacy enhances the capacity to adapt to change, understand new practices and technologies, and improving a household's productivity and income. The size of irrigated area was positive and significant at 1%.

A unit increase in irrigated area would therefore leads to about 74.9% increase per capita income. Besides, Increase in irrigated area will increase farm output and incomes and thereby improve household per capita income. The adoption of the Money maker pump was significant at 1%. The results showed that the Money maker pump adoption increases per capita income by 28.1% relative to that of a non-adopter. This shows that the adoption of a Money maker pump has the capacity to improve livelihoods hence increasing household food security status. These findings are consistent with those of Mangisoni (2006). The regional dummy was significant at 10% implying that the capita income of farm households in the Usigu region was 19.4% lower than the per capita income of those in the Nyang'oma region. From Table 4 the increase in

Table 1. Characteristics of Adopters and Non-adopters of Money maker pump

Characteristics	Adopters	Non-adopters	% Difference	T-test/X^2 value
Age of Household head	41.38	43.32	4.68	1.041
Gender of Household head Male	94.23	98.21	3.98	1.200ł
Years of schooling of Household head	10.63	9.3	12.51	1.801*
Household size	5.97	6.78	13.56	1.693*
Adult male above 15yrs	2.14	1.98	7.48	1.042ł
Adult female above 15yrs	2.12	2.21	4.25	0.358ł
Dependency ratio	0.16	0.77	14.93	1.810*
Irrigated area	0.66	0.58	1.12	1.44
Water availability (%)	48.07	55.35	7.28	0.572ł
Number of extension visits per year	4.31	2.07	51.97	2.456***
Access to credit (%)	5.76	1.78	3.98	1.091*

*** Significant at 1% *significant at 5% ł chi-square (X^2) values

Table 2. Summary statistics of the explanatory variables

VARIABLES	EXPLANATION
Age of household head in years	Age of the household member responsible for final decisions on farm operations and investments
Household size	Total number of members of the household
Household members above 15yrs	Total number of members of the household above 15 yrs. representing the adult workers in the household
Dependency ratio	Ratio of non-income earning members of the household to income earning members of the household
Irrigated area	The area of land irrigated before adoption
Membership of a group	Dummy variable for water user association for farmer group; 1 for members 0 for non-members
Number of extension visit	Number of visits from Mo FA and EW per year
Gender	1 for male 0 for female
Accessibility to credit	1 for accessibility of credit from formal sources and 0 for otherwise
Reliability of water	Dummy variable for availability and accessibility of water all the year round; 1 for reliability of water and 0 for otherwise
Region	Dummy variable for region;1 for Usigu 0 for Nyang'oma

A household is taken as members who eat from the same pot over a 12 month period.

Table 3. Diagnostic statistics explaining the adoption decisions

Variable	Coefficient	Standard error	Z	P-value
Constant	-0.261	0.724	0.361	0.717
Age	0.009	0.016	0.567	0.571
Years of schooling	0.05	0.041	1.211	0.226
Household size	-0.025	0.055	-0.464	0.642
Dependency ratio	-0.808	0.28	-2.88	0.004
Irrigated area	0.248	0.363	0.683	0.495
Membership of group	-0.109	0.296	-0.37	0.711
Number of extension	0.067***	0.336	1.999	0.045
Reliability of water	0.358	0.309	1.159	0.274
Region	-0.766	0.319	-2.421	0.015
Log-likelihood	-60.572			
X^2	28.428			
Probability of X^2	0.0081			
N	108			

** Significant at 1% ** significant at 5%

Table 4. Determinants of Food Security in Bondo Sub-county-Kenya

	Heckman second step with number of extensions as identification variable	Heckman second step and identifying on functional form	Ordinary Least Square (OLS) estimation
Age	-0.001	-0.001	-0.001
Years of schooling	0073***	0.073***	0.072**
Household size	-0.005	0.005	-0.005
Dependancy ratio	0.016	0.016	0.027
Irrigated area	0.739***	0.742***	0.749***
Group Membership	-0.031	-0.35	-0.036
Extension Visit		-0.002	0.001
Water Reliability	-0.001	-0.002	0.007
Adoption of Money maker pump	0.247*	0.0243**	0.281***
Region dammy	-0.205	-0.205	-0.194
Lambda	-0.012	-0.011	

*** Significant at 1%; ** significant at 5%; *significant at 10%

irrigated area had the highest impact on poverty followed by Adoption of money maker pump, and lastly the number of years of schooling. The higher per capita income of farm households in Nyang'oma as compared to Usigu was partly due to its better access to markets.

Conclusion

The paper examined the factors influencing the adoption of Money maker pump technology for irrigation in the two divisions with the highest adoption rates observed in Bondo-Sub county-Kenya. The socio-economic analysis revealed that irrigated farming is practiced mostly by men irrespective of adoption status. There was no significant age differential between adopters and non-adopters of the technology. However, there were significant differences in the number of years of schooling, household size, dependency ratio and the number of extension visits per year between adopters and non-adopters. The factors influencing the probability of adoption were the availability of labour and increase in the number of extension visits. The impact of the Money maker pump adoption as irrigation technology on food security revealed that the area cultivated under irrigation had the highest impact on household food security. The implication of these findings is that extension visits are important to technology adoption. Increased collaboration of private initiatives with local institutions such as extension service could improve the reach of the technology to farmers. Besides increasing the area cultivated under irrigation is likely to reduce household food insecurity.

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REFERENCES

Benin S, and Mugarura, S. 1999. Determinants of change in household level consumption and poverty in Uganda; DSGD Discussion paper No. 27, Development Strategy and Governance Division, IFPRI; URL http://www. ifpri.org/DIVS/DSGD/dp/paper/DSGDP27.pdf

Brouwer C, Prins K and Heibloem M.1990. Irrigation water management methods, FAO: www.fao.org/ docrep/ s8684e.html.

Duncan B, and Brants C. 2004. Access to control over land from a gender perspective; FAO Economic and Social Department, FAO Corporate Document Repository;URL: http://www.fao.org/docrep/007/ae501e/ae501e00.htm

Ellis F, and Mdoe N. 2003. Livelihoods and rural poverty reduction in Tanzania; World *Development;* 31(8):1367-1384.

Jaetzold R, and Schmidt H. (Eds). 1993. Farm management hand book of Kenya, Vol. II western Kenya and Vol. II B (Central Kenya): Natural conditions and farm management information. Ministry of Agriculture/GAT Nairobi and GTZ/Eschborn.

Leyva J, Franco J.A, and Gonzalez .2005.Adoption of Soil conservation practices in olive groves: The case of Spanish Mountains Area, Paper prepared for Presentation at the 11th International Congress of European Association of Agricultural Economics, Denmark, and August 24-27th 2005.

Mendola M. 2005. Agricultural technology and poverty reduction: A micro-level analysis of causal effects; Working paper No 2005-14. Milan, Italy: Universita degli studi di Millano Bicocca.

Mengisoni J. 2006. Impacts of money maker pump irrigation technology on small holder farmers and food security in Malawi. A case study of Blantyre and Mchinji districts. Report written for IWMI, Pretoria-South Africa.

Migotto M, Davis B, Carletto and Beegle K. 2005. Measuring Food Security using Respodents' Perception of consumption Adequacy. FAO Agriculture and Economic Development Analysis Division (ESA) working paper No. 05-10, Pp 3-6.

Ministry of Agriculture.2012. Annual Report, Bondo Sub-county.

Ministry of Water and Irrigation. 2012. Annual Report, Bondo Sub County.

Nowak P. J, and Korsching P.J. 1983. Social and institutional factors affecting the adoption and maintenance of agricultural BMPs; in: *Agricultural Management and Water Quality;* 349-373; lowa State University Press.

Wiersum K.F. 1994.Farmers adoption of contour hedge rows intercropping: A case study from East Indonesia; *Agro forestry* system; 27:163-183.

World Bank. 2000. World development report 2000/2001: Attacking poverty; New York: Oxford University Press.

Zaini A. 2000. *Rural Development, employment, income and poverty in Lombok, Indonesia;* PhD thesis, Georg-Agust-universitat, Goettingen, Germany.

Zaman H. 2000. Assessing the poverty and vulnerability impact of micro-credit in Bangladesh: Development sector policy paper. Washington, D.C.

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