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Research

Assessment of Current Status on Smart Farming Technologies in Batticaloa District, Sri Lanka

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***Abstract*—**Smart farming is an evolving technology that concentrated on improving productivity and rural development. The study was aimed to assess the present situation of farming society towards the e-agriculture and the relationship between different demographic factors of respondents with the usage of ICT application in agriculture in Eravur Pattu, Batticaloa District in Sri Lanka. Therefore, the primary data were composed of randomly selected 1580 farmers between February and June 2019 using a structured questionnaire survey. The data were analyzed with descriptive statistics, Chi-square test, and multiple regression analysis to evaluate the awareness of farmers' awareness of e-Agriculture among the independent variables. The farming community's demographic characteristics showed that 53.2% of respondents belonged to the 45-64 age group. It was also revealed that only 5.1% of respondents were illiterate in this study region. According to this study, 75.9% of farmers have not awareness of e-agricultural concepts in the study area. The relationship between farmers' age and smartphone and Internet usage showed a negative association. The multiple regression analysis showed the positive relationship between education level and Training which influences the ICT utilization on e-Agriculture. In contrast, a negative relationship was observed on age influenced the awareness of e-Agriculture. The study results revealed that younger farmers (Less than 25 years) are using more ICT tools than old aged farmers in the study area.

***Keywords*—**Batticaloa, e-agriculture, farmers' awareness, Information, and Communication Technology, smartphone

I. Introduction

Over the last few decades, Information Communication Technologies (ICT) have been established in the farming sectors to improve agricultural production (Nikkila *et al*., 2010). ICT has been recognized as a dominant tool for achieving countrywide and personal objectives for rural areas' sustainable economic viability (Patil *et al*., 2008). Smart Agriculture (e-Agriculture) is a connection of agricultural informatics, agriculture and entrepreneurship, agricultural facilities, technology diffusion, and Information provided through the Internet and other relevant information communication technologies (FAO, 2005). The availability of such innovative Information can improve farmers' quality decision making on which crops to grow, given past climate conditions and available resources (Rahman, 2009). Chavula (2014) stated that ICTs are automated and communicating bridges between farmers and extension workers. It helps farmers plan the market for a better price for the product and saves money for intermediary farms, which use the prevailing information gap (Anoop *et al*., 2015). Otter and Theuvsen (2014) found that the use of smartphones and e-mail has an optimistic impact on small-scale farmers' agricultural production. Therefore, benefits of ICT for farmers are infinite such as improving farm management, communication flow, and information access. However, implementing these technologies has been sluggish due to several critical challenges to proper communication, either in specific areas or along the supply chain (Sorensen *et al*., 2010). Therefore, the Department of Agriculture (DOA) under the Ministry of Agriculture has been developed many ICT projects for the agricultural sector in Sri Lanka. It has now introduced several e-agriculture plans to overcome the challenges mentioned above (Sri Lanka E-agriculture Strategy, 2016). For examples; The official website of the Department of Agriculture (www.doa.gov.lk); Wikigoviya web site (www.goviya.lk); Krushilanka agriculture portal (www.krushilanka.gov.lk); Rice Knowledge Bank website; Call Center (1920) for Agriculture Advisory Service; e-SMS Service; Govi Mithuru project and Market price Information Systems. The study concentrated in Eravur Pattu, Batticaloa District in Sri Lanka since it is the breadbasket of the entire country for agricultural production especially in paddy production. Even though many studies have been accompanied in this area related to agronomic practices, no investigation has been directed to establish the present status, awareness, and implementation to regulate the current

study styles in use and embracing of e-agriculture in this area. Therefore, this survey aimed to identify the opinions and present status of farmers concerning the e-agriculture and correlation among different socio-economic features of respondents using ICTs in Eravur Pattu, Batticaloa District in Sri Lanka. The paper concludes with discussions on current smart agriculture trends in Eravur Pattu, Batticaloa District in Sri Lanka.

II. Methodology

The study was carried out with the collection of primary data from the farmers, who live in the Eravur Pattu, Batticaloa District in Sri Lanka by questionnaire survey with randomly selected 1580 farmers from February to June 2019. A list of farmers' details in Eravur Pattu is obtained from the Department of Agriculture (Extension), Batticaloa District. The following formula was used to determine the samples size (n); n = N*X / (X + N – 1), where, X = Z/22 - *p*(1-p) / MOE2, and Z/2 is the critical value of the Normal distribution at /2 (for a confidence level of 95%, is 0.05 and the critical value is 1.96), MOE is the margin of error, p is the sample proportion, and N is the population size (Daniel, 1999). The questionnaire had already been tested for its dependability and cogency and verified by questioning from 25 farmers in the region. Respondents were interviewed in their local language at their home or field, and the secondary data were collected from Agrarian Service Center and Divisional Secretariat in Eravur Pattu, Chenkalady. Information on the farmers' demographic characteristics, awareness over the e-agricultural concept, and usage of ICT tools for improving agricultural productivity were included in the questionnaire form. Lastly, the raw data was analyzed using SPSS (Version 25) to determine the farmers' demographic characters and the association between ICT applications of the farmers and demographic factors in the study area.

Table I: Scoring system for variable measurement techniques

Category	Scoring system					
Age	1 for each complete year of age of the respondent					
Education	1 for each year of school education					
Extent of Land	5 for Above 4.0	4 for 3.1-4.0	3 for 2.1-3.0	2 for 1.1-2.0	1 for 0.6-1.0	0 for Below 0.5
Income	1 for each "thousand rupees" income					
Training	1 for Yes	0 for No				
Smartphone usage	1 for Yes	0 for No				
Frequency of use smartphone	5 for Always	3 for Often	2 for Sometimes	1 for Rarely	0 for Never	
Usage of the Internet	1 for Yes	0 for No				
Usage of Social Media	1 for Yes	0 for No				

III. Results and Discussion

A. Demographic characteristics of the farmers

Age is an important factor that regulates the response of an individual during numerous activities in their lifetime. The farming community's demographic characteristics showed that 40.5% and 53.2% of respondents belonged to the 25-44 age group and the 45-64 age group, respectively (Figure 1). Only 1.3% of respondents were under the age of 25, and 5.1% were between 65 and 84. Numerous investigators have the judgment that age has a significant influence on the diffusion, acceptance, and dissemination of inventions (Aldosari, *et al*., 2017). Habib *et al*. (2007) also stated that younger agriculturalists are less resilient to change than the old aged farmers. They receive and adopt innovations and novel technologies willingly and rapidly. Therefore, the farmer's age is the most significant factor in adapting smart farming technologies in this area.

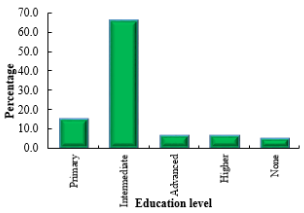

Figure 1: Farmers' educational level

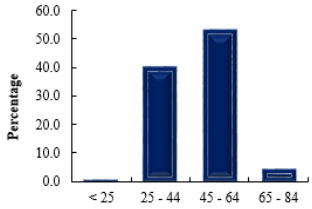

Figure 2: Farmers' age group

Education is a strong correlating factor concerning the level of ICT use by farmers. Figure 2 shows that 5.1% of respondents were illiterate, 15.2%, 65.8%, and 6.3% of respondents have primary (grade 1-5), intermediate (grade 6-11), and advanced level (grade 12-13) education respectively (Figure 2). Only 6.3% of farmers completed their higher education (degree level). Educated individuals are predicted to have positive aspects near farming skills, awareness, and information compared to unschooled people (Habib et al., 2007). The results also supported Boz and Ozcatalbas (2010) findings, as they indicated that the level of education of farmers was closely associated with the usage of ICT. However, many investigators approve that education is a method that produces necessary fluctuations in anthropological performance. The found results recommend that inadequately knowledgeable farmers have little opportunity of getting modern technologies, novel results, and Information conveyed via ICT tools. Therefore, improving the educational level of farmers will be increased the utilization of e-agricultural practices. Based on this study, 7.6% of respondents' families had two members while 3, 4, 5, 6, and 7 members were 29.1%, 30.4%, 20.3%, 10.1%, and 2.5% of total respondents respectively (Figure 3).

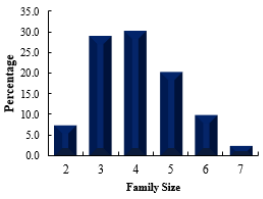

Figure 3: Farmers' family size

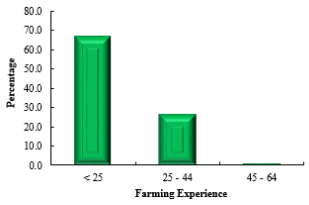

Figure 4: Farming experiences

Experience is significant in any field of life to gain benefits and improve individuals' living standards. According to the

Figure 5: Household income per month

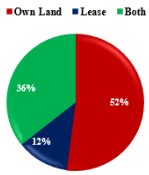

Figure 6: Nature of the Land

study results, around 70% of respondents had less than 25 years of experience in farming, 28% of farmers between 25 and 44 years and only 1.3% had between 45-64 years of experience in agricultural practices (Figure 4). Obinne (1990) specified that farming experience caused more excellent harvests and experienced agriculturalists could raise their productivity by implementing advanced technologies in their agronomic practices. Therefore, the experiences of farmers also another main demographic characteristic of farmers to improve their productivity.

The revenue of farmers is an additional vital aspect that impacts their approach towards gaining modern farming technology and its implementation for improved productivity. According to the data shown in Figure 5, respondents' 14.1% income ranged less than 10,000 LKR per month. Similarly, 30.8% of respondents have 10,001 to 20,000 LKR per month, 23.1% of respondents 20,001 to 30,000 LKR per month, 26.9% of respondents 30,001 to 40,000 LKR per month and 3.8% of respondents earned more than 40,000 LKR per month. Income is subject to straightly or ultimately on the extent of plot holding and directly connects with the implementation of digital agronomic practices (Aldosari, *et al*., 2017).

The data also shows that 52.1% of respondents were land-owners who farmed their land. Similarly, renters accounted for 12.3%, while land-owners and renters accounted for 35.6% (Figure 6). Property status revealed that 1.3%, 3.8%, 3.8%, and 7.6% of respondents had landed for paddy cultivation with an area 0.6 to 1.0 acres, 1.1-2.0 acres, 2.1-3.0 acres, and 3.1-4 acres respectively, whereas 7.6% and 2.5% of respondents had landed for OFC cultivation with an area less than 0.5 acres and 0.6 to 1.0 acres respectively. Land size is one of the factors that determine the adaptation and implementation of smart farming technologies.

Table II: Extent of Land

	Acres	Paddy	OFC	Other crops
		Percentage		
Extent of Land	<0.5	0	7.6	0
	0.6-1.0	1.3	2.5	0
	1.1-2.0	3.8	0	0
	2.1-3.0	3.8	0	0
	3.1-4.0	7.6	0	1.3
	>4.0	83.5	0	0

The data also show that 83.5% of respondents had properties for paddy cultivation with an area greater than 4 acres (Table II). More extent of field holdings means more possible to raise output and productivity to adopt new tools. The extent of field property shows a vital part in the distribution and adoption of current agronomic practices among the agricultural society (Aldosari, *et al*., 2017).

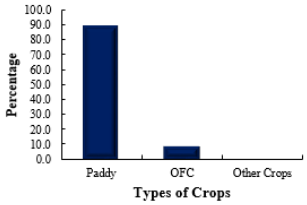

Figure 7: Types of Crops

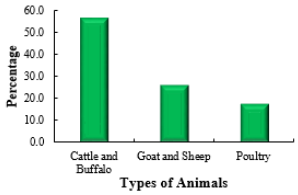

Figure 8: Types of Animals

Furthermore, a maximum of 67.6% of respondents was engaged in occupations other than agriculture (crop farming and animal husbandry) as a part time job such as private/NGO job, business, day-wage labour, household work, and working out of the country and only 32.3% were fully engaged in the occupation of farming. It was also shown that 89.8% of crop farmers are doing Paddy cultivation as the primary cultivation. However, 9.1% and 1.1% of crop farmers practice other field crops (OFC) and other crops, respectively (Figure 7). Furthermore, among 23 farmers who are doing animal rearing, 56.5% of farmers had cattle and buffalo while 26.1% of respondents had engaged in goat and sheep rearing and 17.4% of respondents had poultry respectively (Figure 8).

B. ICT usage of farmers

The smartphone has been spread quickly in developing countries nowadays. The fast evolution of smartphones and the Internet offer innovative things to distribute and obtain information worldwide. In Sri Lanka, there are 23.7 million mobile subscriptions, 11.8% internet access in terms of families, and 19.1% broadband in terms of people with the static Internet being 3%. In contrast, 16% is comprised of a mobile broadband connection. (E-Agriculture Strategy Guide, 2016.). Findings indicate that 39.2% of the farmers possessed a smartphone (Figure 9). A comparative Study was directed for tea producers and poultry farmers in Kurunegala District by Jayathilake *et al*. (2010) who found that 60.6% of the members who utilized ICT related hardware or offices for their business and 76.1% of the members having ICT take-up issues, where media transmission and web revealed a higher effect on the farming area. The farmers focused on the expense of innovation, absence of preparation, trust level in the ICT framework, lack of ICT capability, and absence of mechanical foundation are limits for ICT usage in agriculture (Jayathilake *et al*., 2010).

Figure 10 shows that 1.3% of farmers were using a smartphone all the time for different types of agriculture related activities. At the same time, 8%, 9%, and 21% of

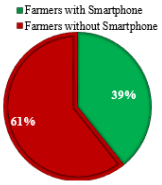

Figure 9: Usage of smart phone

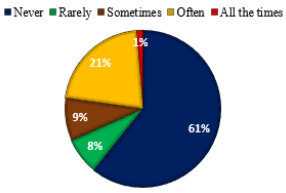

Figure 10: Frequency of using smart phone

farmers were using smartphones rarely, sometimes, and often for agricultural activities respectively and 61% of respondents were never using the smartphone. Mobile phone technology has brought multidimensional benefits to the rural population and aids in rapid and timely interaction, accessibility, and information exchange. Also, cell phones are instrumental in emergencies and emergencies (Sife *et al*., 2010), among recent ICTs, smartphones aid as a means for the actual transmission of Information and data about the farming marketplace. Narmilan *et al*. (2020) delineate the commitment of ICT apparatuses in farming in the Batticaloa District in Sri Lanka who discovered 36.1% of respondents utilized phone as an ICT instrument for agribusiness. The Internet is a useful source for collecting agricultural Information. However, 42% of farms used the Internet for different purposes such as entertainment, education, and so on (Figure 11). Based on farmers' social media usage, almost half of the farmer's population (48%) were not using social media. While, 24.5%, 2.0%, 23.5% of farmers were using Facebook, Twitter, and YouTube, respectively, around 2.0% of respondents were using other social media like WhatsApp (Figure 12). The use of mass media illustrates the approaches with these novel practices. The confidence is that education provides farmers with the aptitude to recognize, understand, and adapt to new Information far quicker than their complements deprived of education. Another examination was led in Ridibendi-ela, Magallamajor water system conspire in Kurunegala District, Sri Lanka which found the more significant part of the farmers like to get data through traditional sources than utilizing Internet (Malsha *et al*., 2011). Therefore, Internet facility is the most key facility for the adoption and implementation of precision farming technologies.

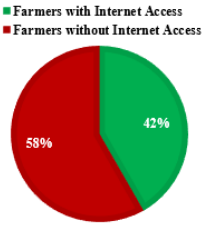

Figure 11: Availability of Internet

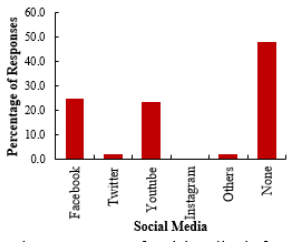

Figure 12: Usage of social media platform

According to the study (Figure 13)., 76% of farmers have not used ICT tools on e-agricultural concepts in this study area. Only 24% of farmers had utilization of ICT on e-agricultural concepts. This means that more than half of the farmers did not have Internet access in their homes and this may be due to the lack of education, the availability of Internet facilities in the area, the lack of Internet accessories, such as laptop, computer, Android Phone Service, etc. (Aldosari *et al*., 2017). Therefore, increasing smart devices' availability is very important for practicing modern technologies in the agricultural sector. Figure 14 indicates only 26.6% of the farmers were obtained e-agriculture related Training from different government and non-government organizations. A similar finding was found in Trans Nzoia County, where most farmers have not operationalized e-agriculture because of lack of awareness. The study found out that 63% of farmers have not implemented e-agriculture because they were unaware (Namisiko and Aballo, 2013). However, they were willing to get Training from different methods such as seminars (34.8%), online learning (12.6%), workshop (4.2%), and face to face training (28.5%) (Figure 15). Organizing extension services and financial support to farmers is essential to improve the shrewd cultivating application by ranchers in Batticaloa District (Narmilan *et al*., 2020). It was suggested that the public authority could carry on e-Agriculture mindfulness projects and workshops to build attention to the e-Agriculture ideas and programs. Further, the Information Communication and Technology Agency can be presented with another versatile application that can help farmers access e-Agriculture programs, subtleties of the item value, subtleties of market value changes. (Pemarathna, 2018). Therefore, providing the training on smart farming for farmers increases the awareness of e-agriculture in the farming community.

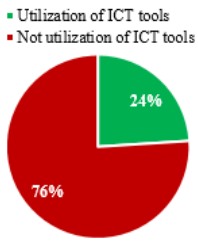

Figure 13: Utilization of ICT in Agriculture

Figure 14: Training related to ICT in Agriculture

C. Relationship between selected variables

The relationship between farmer's age and smartphone usage of the respondents were tested by Pearson Chi-Square test, which is presented in Table III, which shows a statistically significant association (Value: 31.175a and Asymptotic Significance:0.0001) between the age of the respondents and the use of the smartphone (p value:0.05). On the other hand, it was revealed that a significant relationship was established between respondents' age and the use of the Internet as a source of information (Value: 25.850a and Asymptotic

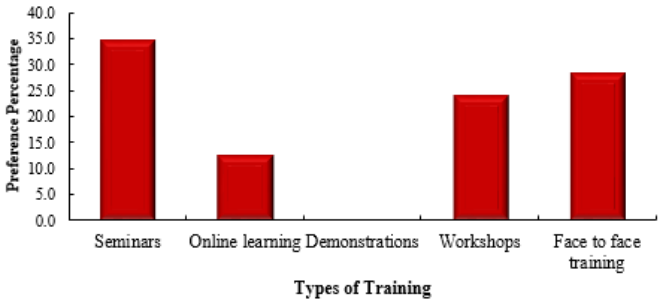

Figure 15: Preference Frequencies to receive the information/training related to e-Agriculture

Significance: 0.0001), as shown in Table 3. This means that Respondents' age has an essential link with the application of Information received via the Internet. As shown in Table III, there is a negative relationship between the farmer's age and ICT use for farming activities. According to the test (Value: 4.411a and Asymptotic Significance: 0.110), no significant difference was found on the relationship between the farming experience of the respondents and Training received related to ICT in Agriculture (Aldosari, *et al*., 2017). In addition to that, Training received, smartphone usage and Internet access show a very significant relationship with the educational level of farmers as shown in Table 2 with the asymptotic significance of 0.007, 0.001and 0.001 respectively. Awuor *et al*. (2016) also noted that the increase in the perception of e-Agriculture suggested that farmers will get Training on how to access Information to improve their agricultural production using ICT devices within their reach. Also, the government needs to formulate robust e-Agriculture policies to support the implementation of ICT-in-agriculture. Therefore, farmers' age, experiences and educational level are most significant factors for the usage of smart phone and Internet to improve the productivity through smart farming technologies.

Table III: Pearson Chi-Square Tests for selected variables

T. No	Treatment	Value	Degree of freedom	Asymptotic Significance (2-sided)
01	Farmers' age vs Smartphone usage	31.175a	3	0.0001
02	Farmers' age vs Internet access	25.850a	3	0.0001
03	Farmers' experiences vs Training received	4.411a	2	0.110
04	Education vs Training attended	14.155a	4	.007
05	Education vs Smartphone availability	37.241a	4	.000
06	Education vs Internet availability	31.909a	4	.000

D. Regression Analysis of selected variables

Estimate the utilization of ICT tools (Dependent variable) on e-Agriculture by the farmers from the independent variables such as age, education level, the extent of land, income, Training, smartphone usage, frequency of smartphone usage, Internet and social media usage, multiple regression analysis was performed which is shown in Table IV. The model shows that the variables such as the extent of land, income, smartphone usage, frequency of smartphone usage, Internet and social media usage does not influence the ICT usage on e-Agriculture (the estimated coefficient at probability level 5 percent). The farmers might have used social media for entertainment purposes rather than educating themselves. However, the multiple regression showed that the variables such as education level and Training influenced the ICT usage on e-Agriculture in a significantly positive manner while age influenced the awareness of e-Agriculture in an incredibly negative way. The R^2 value of 28.8% implies that the variation in the awareness by the farmers' in the use of e-Agriculture was accounted for by the variables included in the model. The F value indicates that the model is significant ($p<0.0001$). Taragola and Gelb (2005) proposed additional factors as follows: lack of ICT domain, lack of knowledge of the benefits of ICT, the complexity of use, lack of technological infrastructure, cost of technology, level of confidence in the System ICT, and lack of Training. Other surveys have shown the influence of education, age, and size of the residence contract on the general adoption of computers and the Internet in Hungary (Csoto and Herdon, 2008). The survey study was conducted by Pemarathna, (2018) in 5 different divisional secretaries' offices such as Ipalogama, Nochchiyagama, Thalawa, Rajanganaya, and Thabuththegama in Sri Lanka. This study revealed that familiarity was 51% and the mix of technologies, mobile phone (26.4%), television (24.5%), radio (24.5%), and telephone (11.9%) was used for their agricultural activities. The primary barrier to implementing e- Agriculture was lack of knowledge (21.1%) of Information and Communication Technology, and it was highlighted that lack of Training (19.6%), language problem, (18.6%), and lack of ICT benefits awareness (13.6%) obstructs the road of e- agriculture implementation. Therefore, the models suggest that the respective authority should consider all the selected independent variables to improve the perception of e-Agriculture by farmers who are living in this study area.

Table IV: Multiple regression coefficients of contributing factors related to the awareness by farmers' in using e-Agriculture

Dependent Variable	Independent Variable	Coefficients	p	R^2	Adj. R^2	F	p
	Age	-0.007	0.048				
	Education Level	0.038	0.005				
	Extent of Land	0.065	0.313				
	Income	0.039	0.263				
Use of ICT	Training	0.206	0.004	0.288	0.244	6.645	0.000
	Smartphone Usage	0.177	0.312				
	Frequency of Use of Smartphone usage	-0.106	0.106				
	Usage of the Internet	0.184	0.227				
	Usage of Social Media	-0.094	0.560				

IV. Conclusion

Agriculture is one of the dominant areas for socio-economic development in Sri Lanka. Technological advances and innovations served as tools to share knowledge and practices on agricultural activities and to improve the living

conditions of farmers, merchants, policymakers, and society in general. Based on the study, the demographic characteristics of the agricultural community showed that more than half of the population belonged to the group of older people. It was also revealed that a few respondents were illiterate in this region. According to this study, most farmers were unaware of smart farming concepts in the study area. The relationship between the age of farmers, the use of smartphones, and the Internet by respondents, and the availability of smartphones and the Internet decreased with farmers' age. To estimate farmers' knowledge about smart agriculture's independent practices, a multiple regression analysis was performed, and the model shows that all independent variables are significantly associated with the perception of precision agriculture by farmers in the study area. According to this study, most farmers have not used ICT tools on e-agricultural concepts in the study area. The respondents' relationship between farmer's age and smartphone and Internet usage was shown that smartphone and Internet availability is decreasing with increasing age. The study results revealed that younger farmers have more perceptions of e-agriculture than old aged farmers.

V. RECOMMENDATIONS AND FUTURE WORKS

Therefore, government and NGOs should focus on farmers' communities about using ICTs, identify the barriers that prevent farmers from using new sources of information and educate them about the use of modern ICTs as sources of agricultural Information. The study also recommends analysis, monitoring, and communication capabilities; improve the awareness, education, and skills of farmers, extension workers, and other end users of the sector to spread credible agricultural knowledge at a distance; Reduce the gap between supply and demand and improve the scope and profitability of Sri Lankan products and services; Promote innovation in electronic agriculture services; Improve financing, investment, and banking coverage of the agricultural sector by taking advantage of electronic and mobile technologies. Further research is still necessary to determine the awareness level of farmers in this study area and also comparative studies are needed to compare the farmers in the different districts

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