

## Agriculture Production Prediction of Major Fruits by Using Machine Learning Technique

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### Abstract

In the machine learning field, prediction of agricultural production is a challenging task. The main issue is providing guidance for the government and farmers, as crop production is less per year compared with the population, and the government provides facilities to farmers to increase their yield production. In this study, time series data from 1980–2015 were used. The data related to different types of fruits, namely apples, citrus, pears, grapes, and bananas, as well as total fruit production. The machine learning technique was used to predict the future production of major fruits in Pakistan. The data were collected from the National Bureau of Statistics of Pakistan, and the output of major fruit production was 1000 tons. The linear regression technique was also used, and the results showed good accuracy. The findings suggested need to further increase the production of fruit; thus, the government needs to introduce new policies for farmers to improve the production of yield. This proposed method is applicable for developing countries (like third world countries) and they can compare production with increasing population and make some new policies to increase fruit production.

**Keywords:** Agriculture Production, Future Prediction, Fruit Prediction, Machine Learning Algorithm.

### Introduction

Artificial neural networks have been used to forecast the market for Thai rice [1] as well as corn and cattle prices [2]. In the present paper, GM is utilized to forecast the price of agriculture products. GM has many applications, such as computing the weights of criteria [3], design evaluation [4], improving picture quality [5], decisions and estimations concerning mechanic motion projects [6], assessing refurbishment plans for power supply systems [7], and evaluating the ventilation of control tunnels [8]. In recent years, numerous scholars around the world have paid added attention to the price of agriculture products, but they have focused on price prediction rather than agriculture production forecasts. However, effectively determining the price of agriculture crops requires accurate forecasting. Market participants have an excellent chance of remaining competitive in their segment if we can accurately predict agricultural yields; this can be an important instrument for sustainable development and poverty reduction in the 21st century, especially in emerging countries like Pakistan [9-13]. (Hajar et al., 2014,) for the production performed using artificial neural network (ANN), the architecture of the neural net was built by incorporating the four test factors as the input layer, methyl ester yield as the response variable, and one hidden layer with different numbers of the constructed neurons [14]. Machine Learning [32-34], (Baruah et al., 2017) used artificial neural network bases model of biomass gasification in fixed bed downdraft gasifiers [15]. (Castro et al., 2017) Artificial Neural Networks (ANN) on biomass prediction of the macauba fruit

components by comparing it to the multiple linear regression method [16]. Agricultural postponement facilities are present in emerging countries, including Pakistan, and their purpose is to address crop management and production issues [17-21]. The postponement services seek to enhance agricultural growth by increasing farmers' technical information, use of effective information systems, and farm management skills to improve production, thereby supporting the economy at both the local and global levels [22-27]. For the support of farmers, to promotion the agricultural production, it make institutional and through it enable the farmers to increase and market their production and ensure sustainable agricultural development [31]. In this article, we predict the agricultural production of fruit in Pakistan. Such forecasting will be beneficial for farmers and the government, as accurate prediction can help them in determining which crops to focus on—less production of some crops may be needed, while more production may be required for others. The government can provide more facilities and loans to farmers growing the less-produced crops and establish new policies to increase production with the increasing population. The remainder of this paper is organized as follows: Section 2 describes the materials and methods, while section 3 gives the results and discussion. Finally, section 4 provides the conclusion and recommendations.

### Materials and Method

Price prediction can be carried out using two methods, namely the technical and fundamental approaches. In the technical method, statistical analysis of data is carried out; in contrast, the fundamental method considers every available detail, as well as growth agents that affect institutional production. It can be performed on present and historical data with the objective of establishing fruit production forecasts. In this paper, we use a technical analysis employing a machine learning algorithm to predict fruit production. The linear regression method is used for fruit production forecasting, and publicly available data on the production of different fruits in Pakistan are collected. Machine learning is a well-established technique with a wide range of applications, and it has been broadly studied for its capacity to predict fruit production. However, the inputs considered are mostly derived from the data within the yearly fruits data. Such separation may ignore the factors affecting production. Figure 1 show the fruit production prediction model. In Figure 1 we have different type of fruit data and that data is historical data and the second step we apply linear regression techniques and predict the fruit production are increasing or decreasing, which showed in third stage of Figure 1, yes or no.

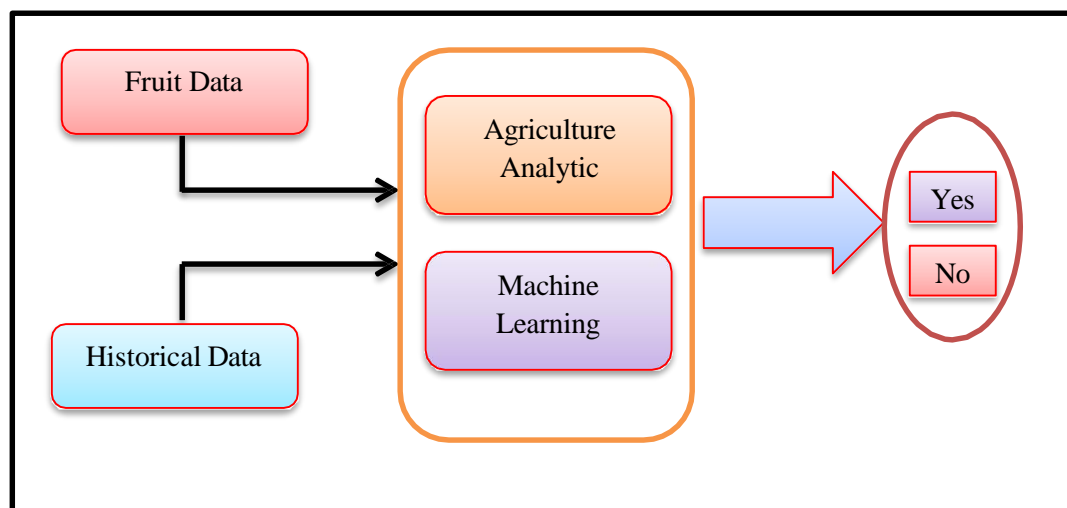


Figure 1: Agriculture Production Prediction Model

## Pakistan's Major Fruits Production Prediction Using Machine Learning

The machine learning algorithm, Linear regression used for statistical classification techniques and the results are determined by one or more independent variables, so the nature outcome of linear regression model is categorical and linear regression model which can be represented as like. In the equation (1) have two variables  $x$  is the independent variable and the  $y$  is dependent variable.

$$Y_i = \beta_0 + \beta_1 x_{i1} + \dots + \beta_p x_{ip} = X^T \beta + \epsilon_i, i = 1 \dots n \quad (1)$$

Where  $T$  denotes the transpose, so that  $X^T \beta$  is the inner product between vectors  $x_i$  and  $\beta$ .

So the vector form is =  $Y = X \beta + \epsilon$  (2)

The confidence interval of  $E(y|x^*)$  so the average of expected value of  $y$  for a specific given  $x^*$ .

$$\hat{y} \pm t_{n-2}^* S_y \sqrt{\frac{1}{n} + \frac{(x^* - \bar{x})^2}{(n-1)s_x^2}}$$

Where  $S_y$  is the standard deviation of the residuals, calculated as and  $S_y$  is called residual standard error in R regression output.

$$S_y = \sqrt{\frac{\sum (y_i - \hat{y})^2}{n-2}} \quad (4)$$

The proposed model consists of  $m$  vectors in a  $d$  dimensional features space. In the features space  $x$  points, which project it on  $m$  and convert it into  $z$  real number, the range of the real number is  $-\infty$  to  $+\infty$ .

$$Z = C + m \cdot x = C + m_1 x_1 + m_2 x_2 + \dots + m_d x_d \quad (5)$$

Future prediction is a complicated system task, even in stock market or education institute. Forecasting of education institute's the trend predict the hidden relationship of characterized, data intensity, noise and high degree of uncertainty. In fruits prediction trend forecasts, the trend of next year production 'high' or 'low'. So for the fruits prediction and the trend prediction, linear regression method outfits fine. So the highly connected features are trained for the linear regression model. The training data model built and the same model is tested on testing data. Meanwhile entirely the features were extremely connected; we have got around 49% accuracy. Through confusion matrix it can be calculated.

$$Accuracy = \frac{(\text{True Positive}) + (\text{True Negative})}{(\text{True Positive}) + (\text{False Positive}) + (\text{False Negative}) + (\text{True Negative})}$$

Where true positive (TP), trend is up and it is classified as up. The True Negative (TN), trend is down and it is classified as down. False Positive (FP), trend is down but it is classified as up. False Negative (FN), trend is up but it is classified as down. Algorithm 1 shows the detailed steps of agricultural fruit production prediction. In algorithm 1:  $x$  is the data set and total 35 year's fruits production data we have considered.  $M$  is the fruit type and total six types of fruits, so the matrix  $M$  become  $1 \times 6$  and the  $P$  matrix mean, every year production, total 35 years production and so the  $P$  matrix become  $35 \times 6$ . Every  $P$  matrix assign a weight  $W_1, W_2 \dots W_{35}$  then compute the distance  $D$  by sliding window. In the final step computer, the moving average of matrix, then computer the central moving average matrix  $Q$  and finally predict the future production of fruits.

### **Algorithm 1:**

Agriculture Fruit Production Prediction

**Input:** A set of Fruit data  $X$

**Output:** Fruit data  $X$  future prediction  $P$

### **Algorithm**

**Step 1:** Take matrix  $M$  of last one year data, data size  $1 \times 6$

**Step 2:** Take matrix  $P$  of thirty five years pervious data, data size  $35 \times 6$

**Step 3:** Make sliding window of window of size  $1 \times 6$  for each matrix  $P$  as  $W_1, W_2 \dots W_{35}$

**Step 4:** Compute Euclidean distance of sliding window  $D_1, D_2, D_3 \dots D_{35}$

**Step 5:** Select matrix  $W_i$  as

o  $W_i =$  corresponding matrix (min  $D_i$ )

o  $\forall i \in [1, 35]$

**Step 6: For  $I=1$  to  $n$**

□ For computer the moving average of matrix  $D$  as  $Q$

□ For computer the central moving average matrix  $Q$  as  $R$

□ Mean 1 = mean of  $Q$

□ Mean 2 =mean of  $R$

□ Prediction  $P = (\text{Mean1} + \text{Mean2}) / 2$

□ Add  $P$  to pervious data for getting prediction

**Step 7: End**

## **Results and Discussions**

### **Data Set:**

Time sequences data were collected from the (National Bureau of Pakistan). To inspect the association between the agriculture GDP and the outputs of major fruits crops, yearly time sequences data from 1980 to 2015 were used. The data were collected from the Economic Survey of Pakistan (various statistical supplements), Pakistan Statistical Year Books, Government Publications and the Federal Bureau of Statistics. The variables used in this study are fruit production, output of the apples in (1000) tones, output of the citrus is (1000) tones, output of pears (1000) tones, output of grapes in tones (1000), and output of bananas in tones (1000), and output of total fruit is in tones (1000), Table 1 shows.

Table 1: The Detail Description of Datasets.

Fruit Types	Study Ranges	Production
Apples	1980-2015	158,880
Bananas	1980-2015	4,340
Citrus	1980-2015	3280
Pears	1980-2015	3757
Grapes	1980-2015	6055
Fruits	1980-2015	976

Table 1: National Bureau of Pakistan

### ***Apples Production***

The apple needed temperate climate to grow, and it is native to many parts of Asia and Europe. In the 94 countries, apple worldwide is fourth extensively produced deciduous fruit. The production of apples in 4.85 million hectares of land was 69.60 million metric tons [28]. However, the global climate is changing, and according to the Fourth Assessment Report of the United Nations (UN) International Panel on Climate Change, it will continue to change in the future. The 11 years of 1995–2006 were the warmest years on record since 1850 [31]. The apple production in Pakistan in 1980 was 99.2 tons, tones and 1990 (1000) the production of apples will increased and reach at 232.4 tones (1000), the production in 2000, 377 tones (1000), the production will reduce in 2010, and reach 366 tones (1000) and 2015 the production will increase and reach at 606 tones (1000). The production of apples, up and down from 1980 to 2015, here Figure 2 shows the production of apples from 1980 to 2015 and forecast of the apples production in Figure 2 show, the trend of prediction is increased every year is 12 to 12.3232 %, we have predicted the production of apples from 1980 to 2015.

### ***Bananas Production***

Bananas are one of most important fruits and staple foods, along with maize, wheat and rice. More than 130 countries produce 107 million metric tons bananas were produce and the area that were used for this purpose is 0.1 percent and for total trade value of 9 billion US dollars [36] and the approximately retail value 25 billion US dollars. The main consumption of bananas is domestic and only 17 % of bananas are exported to foreign markets per year. From the Latin America, one third of bananas are exported, by about the similar amount intended for United States or the Europe [29]. The banana marketplace is considered by heavy vertical integration and horizontal within the value chain and a low-cost and highly competitive export market focused on Latin America. Bananas are typically grown on plantations, and certain viruses, pests and fungi have spread in epidemic proportions over the last few decades, allegedly a result of decreased immunity created by monoculture practices [30]. The banana production in Pakistan, 1980 was 125.3, tones (1000) and 1990 the production of banana will increased and reach at 209.8 tones (1000), the production in 2000, 125 tones (1000), and the production will be in 2010, and reach 155 tones (1000) and 2015 the production will increase and reach at 119 tones (1000). The production of banana, up and down from 1980 to 2015, here Figure 2 shows the production of banana from 1980 to 2015, and forecast of the apples production in Figure 2 show, the production of banana frequently decrease every years

and the trend of prediction show the value is 0.37297%, we have predicted the production of apples from 1980 to 2030.

### ***Citrus Production***

In Kinow (oranges) production the Pakistan is the sixth largest producer, and the production rate is 2.1 million tones. In 1997, the Pakistan world market share during the year was 0.9% and 3.6% in term of volume and value respectively. The citrus production of Pakistan is also largest, and this part of world has quality to produce unique variety 'Citrus Reticula'. Rendering to an estimate approximation 95% of the total Kinow produced all over the world is grown in Pakistan. Citrus cultivars are grown up in varying amounts in countries with subtropical or tropical climates. Citrus stances first in area and production amongst the world's tree fruits. In Pakistan the citrus fruits are very important fruit, and its production is 1.5 MMT annually, on the area of 160000 hectares. The citrus grown in Pakistan in all four provinces and Punjab produce 95% crop, because the Punjab have great population and Punjab have adequate water and favorable growing condition. Citrus is distributed into different groups, Mandarine, Grapefruit, Sweet oranges and Lime & Lemon that are grown commercially. The citrus production in Pakistan, 1980 was 86.7, tones and 1990 (1000) the production of citrus will increase and reach at 171.1 tones (1000), the production in 2000, 1862 tones (1000), the production will increase in 2010 and reach 2150 tones (1000) and 2015 the production will increase and reach at 2168 tones (1000). The production of citrus, up and down from 1980 to 2015, here Figure 2 shows the production of citrus from 1980 to 2015 and forecast of the citrus production in Figure 2 show, the trend of prediction is increased every year is 83 to 83.0742 %, we have predicted the production of citrus from 1980 to 2030.

### ***Pears Production***

After few major fruits the pear is one of most important fruits, such like country Pakistan temperature region. Pears can grow under temperature and subtropical regions like due to their wider climate and soil adaptability. The pears production in Pakistan, 1980 was 27.7, tones and 1990 (1000) the production of pears will increase and reach at 32.3 tones (1000), the production in 2000, 36.9 tones (1000), the production will increase in 2010 and reach 42 tones (1000) and 2015 the production will increase and reach at 45 tones (1000). The production of pears, up and down from 1980 to 2015, here Figure 2 shows the production of pears from 1980 to 2015 and forecast of the pears production in Figure 2 show, the trend of prediction is increased every year is 374584%, we have predicted the production of pears from 1980 to 2030.

### ***Grapes Production***

Now a days grapes farming is very popular in the Pakistan and farmer can earn lot of money through grapes forming, the mainly provided varieties of grapes from Punjab, through grapes forming farmer can earn sixteen Lakh to twenty Lakh per Acre. Farming industry providing grapes agribusiness consultancy in Pakistan and furthermore provide different varieties of grapes in Pakistan. Pakistan has a nursery of grapes to sell their clients and have different varieties of grapes and only European grapes are cultivated for eating. More than 70% of grapes are growing in Balochistan and some in Khyber Pakhtunkhwa. The grapes production in Pakistan, 1980 was 29.2, tones and 1990 (1000) the production of grapes will increase and reach at 32.6 tones (1000), the production in 2000, 40 tones (1000), the production will increase in 2010 and reach 65 tones (1000) and 2015 the production will increase and reach at 66 tones (1000). The production of grapes, up from 1980 to 2015, here Figure 2 shows the production of grapes from 1980 to 2015, and forecast of the grapes production in Figure 2 show, the trend of prediction is increased every year is 1 to 1.339897 %, we have predicted the production of grapes from 1980- 2030, we have get the good accuracy.

## Fruits Production

All fruits grown up in Pakistan will make a somewhat unlimited list. The very common fruits inside and outdoors of the country are mangoes fruits, citrus, banana, apple, peaches, apricots, guavas, dates, grapes, plums, papaya, fig, melon, barriers, musk melon, watermelon, pomegranate, prunes, and cherry etc. Pakistan is lucky in having excessive variety in its soil and in its ecological and climatic conditions, reaching from tremendously warm to temperate and also very cold in winter. This allows the country to breed many kinds of plants, shrubs, trees, creepers and vines, which produce a big variety of vegetables and fruits. The fruits production in Pakistan, 1980 was 286.7, tones and 1990 (1000) the production of fruits will increase and reach at 449.8 tones (1000), the production in 2000, 712.4 tones (1000), the production will reduce in 2010 and reach 1163.2 tones (1000) and 2015 the production will increase and reach at 1325.4 tones (1000). The production of fruits, up and down from 1980 to 2015, here Figure 2 shows the production of fruits from 1980 to 2015 and forecast of the fruits production in Figure 2 shows, the trend of prediction is increased every year is 12 to 12.3232 %, we have predicted the production of fruits from 1980 to 2030.

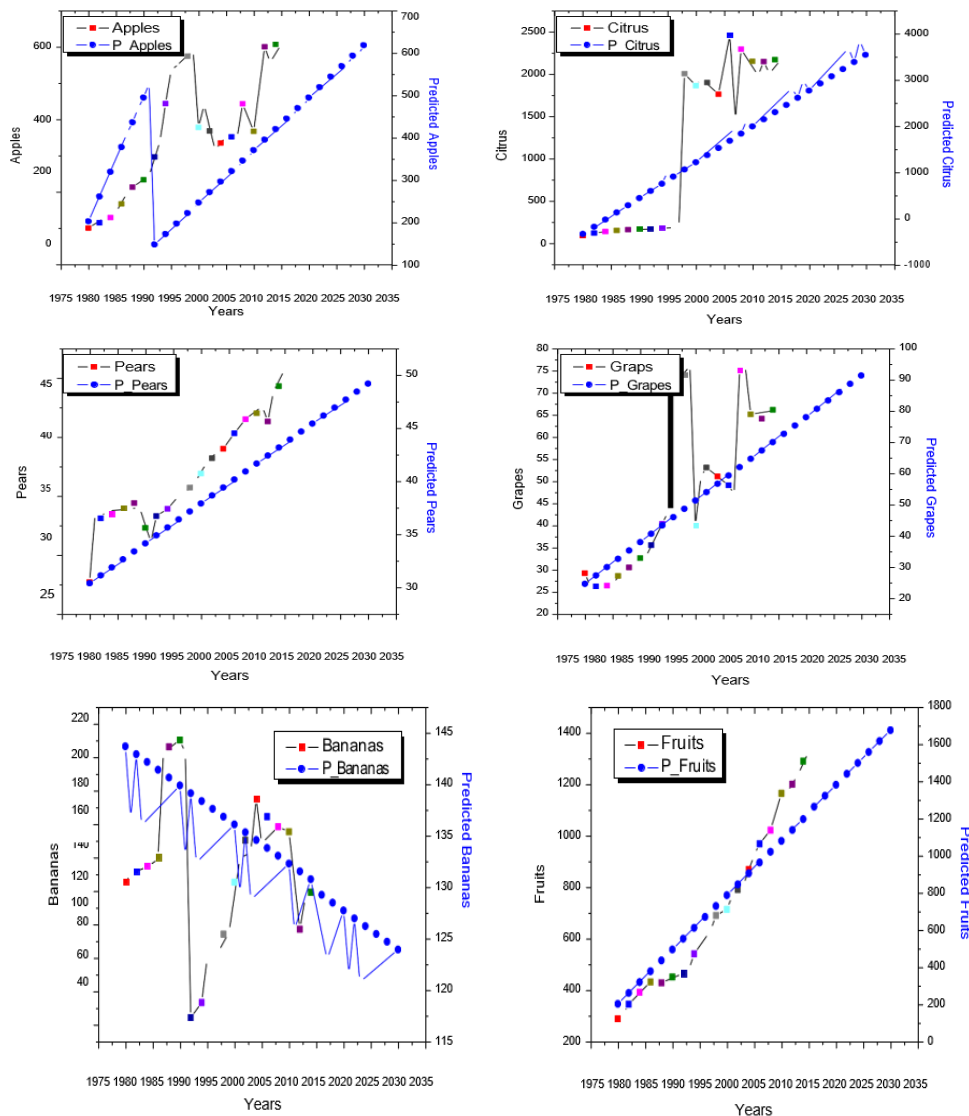


Figure 2: Pakistan Fruits Production Prediction (Apple, Bananas, Citrus, Pears, Grapes, Fruits)

## Discussion and Recommendation

Fruits provide the necessary nutrition supplements to our body and also improve the body condition. Fruits provide perfect supplement for hormonal imbalance. Fruits provide many positive results. So far fruits have cured some of the ailments of the body also. Fruits contain water content that maintains necessary moisture in the body. Fruits contain a substance called fructose which is a better supplement than sugar. All the fruits improve the sodium level content in the body and hence people with low sodium content should consume more fruits. In this article we have taken different fruits data of Pakistan and predict the future production of these fruits, for prediction we have used liner regression model and get the accuracy is 49%. The apples production in 2015, 606 tones (1000). According to the future prediction in 2030 the apples production will be 753.6175 tones (1000) and the citrus production was in 2015, 2168 tones (1000) and future prediction, in 1930, 3540.23 tones (1000) and the pears production was in 2015, 45.7 tones (1000), the future prediction of pears in 1930, 49.18108 tones (1000) and the production of grapes was in 2015, 66 tones (1000) the prediction of grapes will be 91.13519 tones (1000) , in 2030 and the production of bananas was 119 tones (1000), in 2015 and prediction of bananas will be 123.9072 tones (1000), in 2030 and the production of fruits was 1325.4 in 2015 tones (1000) and the predicted production of fruits is 1674.17 tones (1000), in 2030. The population of Pakistan is continually increasing, and the more fruits production will need with increasing population and the government responsibility to provide the all facilities to the framers of fruits production, to increase their fruits production. Table 2 shows the current production (2015) and the future prediction production (2030) of fruits in Pakistan.

Predicted Output Production				
Data Sets	Predicted data	Current Production, Tones (1000)	Predicted Production, Tones (1000)	Accuracy
Fruits data of Pakistan 1970-2015	1980-2030	1325.4	1674.17	52.02±1%
Apples data of Pakistan 1970-2015	1980-2030	606	753.6175	50.03±1%
Citrus data of Pakistan 1970-2015	1980-2030	2168	3540.32	48.8±1%
Pears data of Pakistan 1970-2015	1980-2030	45.7	49.18108	49.03±1%
Grapes data of Pakistan 1970-2015	1980-2030	66	91.13519	51.18±1%
Bananas data of Pakistan 1970-2015	1980-2030	119	123.9072	48.05±1%
Average	Nil	721.6833	1038.5887	49.8516±1%

*Table 2: Data and Results*

## Conclusion

In this paper a prediction model has been built that uses data analytical capabilities, agriculture analytics and machine learning to periodically predict the trend about agriculture fruits production of Pakistan. Model shows that sentiment analysis of the agriculture data complements proven technical analysis methods such as regression analysis. It shows that volatility of the yearly production of different fruits and the future performance of the system is affected by the economic, future production and influence on the population. Exploiting agriculture fruits data in addition to numeric data increases the quality of the input and gives improved predictions. We have used liner

regression model, and this model would improve the accuracy of the prediction and the accuracy is 49.8516 %. This article provided better guidelines for farmers, now how much production of fruits Pakistan and what is future production and how to increase the production of fruits in future, with increasing population and it also helpful to any government to make better policies to increase the future production of fruits and facilitates to the farmers to increase fruits production. This model is also applicable to any country's agriculture production data, to predict their agriculture production.

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