



Predicting the Amount of Pineapple Production in Sumatra Using the Fletcher-Reeves Algorithm

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ARTICLE INFO	ABSTRACT
Article history: Received June 08, 2022 Revised July 02, 2022 Accepted August 28, 2022 Keywords: ANN Fletcher-Reeves Gradient Pineapple Fruit Production Prediction	Pineapple is a kind of organic product from the Bromeliaceae family which has the logical name <i>Ananas comosus</i> Merr. Pineapple plants have weathered skin and pointed leaves on top. The taste of new pineapple is a combination of sweet and slightly sharp. Pineapple is high in L-ascorbic acid, which helps cells fight damage, according to the Linus Pauling Organization at Oregon State College. L-ascorbic acid is also useful in managing medical conditions, such as heart disease and joint pain. However, due to the absence of consideration from the regions and local governments regarding pineapple on the island of Sumatra, it has caused several problems, especially data on pineapples related to the advantages, content, and uniqueness of pineapples to be used as pineapples. chaotic and diminishing pineapple production, especially on the island of Sumatra. Therefore, it is important to make a wish to know the assessed amount of Pineapple Organic Product Crop Creation on the island of Sumatra so that the public authorities on the island of Sumatra have endlessly clear references to decide on an approach or make major progress so that the development of pineapple on the island of Sumatra does not diminish. The method used in making predictions is the Fletcher-Reeves algorithm and is a method in ANN. In this study, the data used was the number of pineapple fruit plants on the island of Sumatra in 2012-2021 obtained from BPS. Given this information, organizational design models will not be fully defined, including 4-10-1, 4-15-1, 4-20-1, 4-25-1 and 4-30-1. Of these 5 models, then Training and Testing is done and the best architectural model result is 4-15-1 with the least (less) Performance/MSE test. With the lowest Performance/MSE level of 0.005488189 compared to the other 4 models. <i>This is an open access article under the CC BY-NC license.</i>



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1. INTRODUCTION

Pineapple (*Ananas comosus*) is a tropical fruit plant with a sweet taste and an edible acidity, it is also the most economically important plant in the Bromeliaceae family (Hendra & Siregar, 2021). Pineapple is native to South America, and has been cultivated there for centuries (Aku & Tengah, n.d.).

In Indonesia, many individuals are developing pineapple plants. The benefit of pineapple is to keep the stomach related skeleton in your body (Pavan et al., 2012). The results show that the chemical, one of the catalysts in pineapple, is very good for the organs associated with the

stomach and can reduce the effects of diarrhea (Sutomo & Kurnia, 2016). In addition, bromelain can also relieve disorders of the respiratory tract, pineapple is known to have normal diuretic properties (Annisa, 2015). Thus, this tropical natural product can maintain health while helping the kidneys as an organ that works to remove toxins from the body (Savitri, 2016). In addition, pineapple can also lower pulse rate and inhibit plaque formation in blood vessels (Dalimartha & Adrian, 2011).

In this review, what will be discussed is the Total Production of Pineapple Fruit Plants on the island of Sumatra which consists of the regions of Aceh, North Sumatra, West Sumatra, Riau, Jambi, South Sumatra, Bengkulu, Lampung, Kep. Bangka Belitung, and Kep. Riau (Fauzi et al., 2012). The information comes from BPS Indonesia. Given the information on the Number of Pineapple Fruit Plants on Sumatra Island in 2012-2021 data obtained from the BPS Sumatra Island, it is known that the province with the highest production of pineapples was in 2012 in Lampung Province, amounting to 705,883 tons. In 2013 the area with the most pineapple production was still held by Lampung Province, which was 662,588 tons. Until 2014-2021, the largest number of pineapple production on the island of Sumatra is still held by the Province of Lampung. More specifically can be found in table 1.

Table 1. Number of Pineapple Plants Production on Sumatra Island
Source: Central Bureau of Statistics (BPS)

Province	Year									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Aceh	734	1356	1143	1203	513	649	790	703	495	545
North Sumatra	16503	15825	13826	14568	16052	16354	22318	23751	22816	26200
West Sumatra	414	293	265	190	192	194	213	289	311	278
Riau	35488	21427	13253	95019	79327	94129	74388	10748	96172	92445
Jambi	32756	14952	13762	47275	44265	66094	14285	21881	15639	14486
South Sumatra	47604	13733	17985	13485	10901	57291	57521	57990	57887	47341
Bengkulu	385	333	236	200	172	156	243	228	319	482
Lampung	70583	66258	69923	62281	63305	453812	534775	560026	722620	585608
Kep. Bangka Belitung	6827	6052	2567	6089	4311	5266	2826	7372	15568	24107
Kep. Riau	5569	4054	2242	1952	1757	932	541	999	1709	1851

Given the importance of pineapple for health, especially for people on the island of Sumatra, it is important to take into account the amount of production of organic pineapple products (Press, n.d.) which is assessed on the island of Sumatra so that public authorities on the island of Sumatra Have a clear reference without stopping to decide on arrangements or make important steps for the manufacture of pineapple on the island of Sumatra will not decrease from now, maybe develop consistently (Shinta, 2001). A great method used to make predictions is backpropagation (Utomo, 2022). The method used in this situation is the Fletcher-Reeves Algorithm which is nothing but an ANN method in most cases used in making predictions (Anam et al., 2021), for the reason that (Windarto et al., 2020). This technique can predict information based on past information, so that existing results are obtained after proactive learning and preparation for remembering information that has occurred (Rehalat, 2014).

2. RESEARCH METHOD

The information sorting technique used is a quantitative method in conducting this research, in particular (Hines, 1993). Data on the number of pineapple plants on the island of Sumatra were obtained through the BPS Sumatra website (Dewi Susanti et al., 2021). The Fletcher-Reeves Algorithm technique which is a method in ANN is used in this research (Zhang et al., 2006). This technique can make forecasts or predictions by looking at past information (Sharma et al., 2007). As a general rule, how the Fletcher-Reeves function can be understood is as follows:

1. Entering Training Data or Entering Input Data
 $p = [0.1006 \ 0.2869 \ 0.1003 \ 0.5021 \ 0.1369 \ 0.6395 \ 0.1002 \ 0.9000 \ 0.1075 \ 0.1061;$
 $0.1013 \ 0.1010 \ 0.1001 \ 0.3427 \ 0.2694 \ 0.2555 \ 0.1002 \ 0.8509 \ 0.1067 \ 0.1044;$
 $0.1011 \ 0.1009 \ 0.1001 \ 0.2501 \ 0.2558 \ 0.3037 \ 0.1001 \ 0.8925 \ 0.1027 \ 0.1023;$
 $0.1012 \ 0.2649 \ 0.1000 \ 0.2075 \ 0.1534 \ 0.2527 \ 0.1000 \ 0.8059 \ 0.1067 \ 0.1020]$
2. Input Data Output Target

- ```

t=[0.1004 0.1011 0.1000 0.1897 0.1500 0.2234 0.1000 0.8175 0.1047 0.1018]
3. Create a Multi Layer Neural Network
net = newff(minmax(p),[10,1],{'tansig','logsig'},'traincgf');
4. Generate weight and tilt
net.IW{1,1}
net.LW{2,1}
net.b{1}
net.b{2}
5. Default limit value Conjugate gradient backpropagation with Fletcher-Reeves (traincgf)
net.trainParam.epochs = 1000;
net.trainParam.shows = 25;
net.trainParam.showCommandLine = 0;
net.trainParam.showWindow = 1;
net.trainParam.goals = 0;
net.trainParam.time = inf;
net.trainParam.min_grad = 1e-6;
net.trainParam.max_fail = 5;
net.trainParam.searchFcn = 'srchcha'
6. Doing Training
net = train(net,p,t)
7. Checking the performance value obtained
[a,Pf,Af,e,perf] = sim(net,p,[],[],t)
8. Enter Input information (Test)
p1=[0.1005 0.2809 0.1000 0.2041 0.1730 0.1633 0.1000 0.6023 0.1057 0.1009;
0.1007 0.3469 0.1001 0.1822 0.2580 0.1635 0.1001 0.6920 0.1030 0.1004;
0.1006 0.3629 0.1001 0.2188 0.3422 0.1640 0.1001 0.7200 0.180 0.1009;
0.1004 0.3524 0.1002 0.2063 0.2730 0.1639 0.1002 0.9000 0.1171 0.1017]
9. Enter target information (test)
t1=[0.1004 0.3900 0.1001 0.2022 0.2603 0.1522 0.1004 0.7483 0.1265 0.1019]
10. Re-enactment using test information from training results
[a,Pf,Af,e,perf] = sim(net,p1,[],[],t1) (Anam et al., 2017).

```

## 2.1 Data source

In this study, the data used were sourced from the website for information on the number of pineapple production on the island of Sumatra in 2012-2021 (Table 1) which was obtained from the BPS Sumatra website (Central Bureau of Statistics).

## 2.2 Research Structure

The research structure used in dealing with the problem is shown in Figure 1.

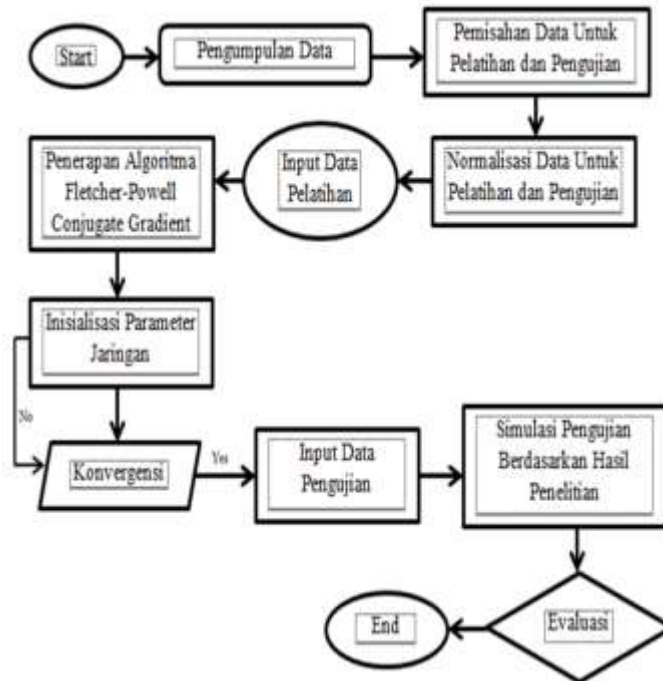


Figure 1. Research Step

From the description of the system above, each stage can be understood below:

1. Data collection  
In this step, the BPS data obtained is data on the Total Production of Pineapple Fruit Plants on the Island of Sumatra
2. Data Separation For Training and Testing  
At this stage, information is shared for training and testing of 2012-2021 information for 2012-2015 as a target with 2016 to be used as training data, and information for 2017-2020 with a 2021 target to be used as testing information. Once partitioned into 2 sets, the information will be normalized using sigmoid capabilities.
3. Normalization of Data for Training and Testing  
At this stage, normalization of training and testing information is carried out involving the equations in Figure 2.
4. Input Training Data  
At this stage the normalized data is placed into the Matlab 2011b application for handling, then a multi-layer neural network (training data input) will be created.
5. Application of the Fletcher-Reeves Algorithm  
At this stage, a calculation or Fletcher-Reeves algorithm will be applied where for the formation of this multi-faceted brain network utilizing the ability of tansig and logsig.
6. Network Parameter Initialization  
At this stage, initialization of network parameters is carried out based on the training function used (traincgf).
7. Convergence  
Then at this stage enter the command to perform the preparation interaction and see the results when the performance is obtained and do it until the training gets convergence.
8. Test Data Input and Test Simulation Based on Research Results

Then run the normalized test data. However, the results of the training that have not received convergence, must return to the initialization stage of network parameters. Then next with the simulation of test data based on the results of the training.

## 9. Evaluation

The last stage is evaluation in order to be able to check or assess the best architecture seen from the smallest (slight) Performance/MSE test.

## 2.3 Data Normalization

The data is normalized which is used in condition (1) which will produce a value somewhere in the range of 0 and 1 (shouldn't be 0 and 1, let alone more than that), because it is an arrangement of standardization normalization (Setiawan, 2019).

$$x' = \frac{0,8(x-a)}{b-a} + 0,1 \quad (1)$$

Description: (X' = is the result of normalized data, x = is normalized data, a = is data with the smallest value, b = is maximum data with the largest value, 0.8 and 0.1 = is the value of normalization failure).

## 3. RESULTS AND DISCUSSIONS

### 3.1 Normalization Results

The attached table 2 is the result of normalization of the training data used, specifically from 2012 to 2015 with 2016 as the target. This information is seen from table 1. This information is normalized by using the sigmoid function as written in condition (1).

**Table 2.** Normalization of Training Data`

| No | Province              | 2012   | 2013   | 2014   | 2015   | 2016   |
|----|-----------------------|--------|--------|--------|--------|--------|
| 1  | ACEH                  | 0.1006 | 0.1013 | 0.1011 | 0.1012 | 0.1004 |
| 2  | NORTH SUMATRA         | 0.2869 | 0.1010 | 0.1009 | 0.2649 | 0.1011 |
| 3  | WEST SUMATRA          | 0.1003 | 0.1001 | 0.1001 | 0.1000 | 0.1000 |
| 4  | RIAU                  | 0.5021 | 0.3427 | 0.2501 | 0.2075 | 0.1897 |
| 5  | JAMBI                 | 0.1369 | 0.2694 | 0.2558 | 0.1534 | 0.1500 |
| 6  | SOUTH SUMATRA         | 0.6395 | 0.2555 | 0.3037 | 0.2527 | 0.2234 |
| 7  | BENGKULU              | 0.1002 | 0.1002 | 0.1001 | 0.1000 | 0.1000 |
| 8  | LAMPUNG               | 0.9000 | 0.8509 | 0.8925 | 0.8059 | 0.8175 |
| 9  | KEEP. BANGKA BELITUNG | 0.1075 | 0.1067 | 0.1027 | 0.1067 | 0.1047 |
| 10 | KEEP. RIAU            | 0.1061 | 0.1044 | 0.1023 | 0.1020 | 0.1018 |

Table 3 attached is the result of the normalization of the tests used, especially 2017-2020 with the same target in 2021. This information is taken based on table 1. This information is also normalized using the sigmoid function as written in condition (1).

**Table 3.** Normalization of Test Data

| No | Province              | 2017   | 2018   | 2019   | 2020   | 2021   |
|----|-----------------------|--------|--------|--------|--------|--------|
| 1  | ACEH                  | 0.1005 | 0.1007 | 0.1006 | 0.1004 | 0.1004 |
| 2  | NORTH SUMATRA         | 0.2809 | 0.3469 | 0.3629 | 0.3524 | 0.3900 |
| 3  | WEST SUMATRA          | 0.1000 | 0.1001 | 0.1001 | 0.1002 | 0.1001 |
| 4  | RIAU                  | 0.2041 | 0.1822 | 0.2188 | 0.2063 | 0.2022 |
| 5  | JAMBI                 | 0.1730 | 0.2580 | 0.3422 | 0.2730 | 0.2603 |
| 6  | SOUTH SUMATRA         | 0.1633 | 0.1635 | 0.1640 | 0.1639 | 0.1522 |
| 7  | BENGKULU              | 0.1000 | 0.1001 | 0.1001 | 0.1002 | 0.1004 |
| 8  | LAMPUNG               | 0.6023 | 0.6920 | 0.7200 | 0.9000 | 0.7483 |
| 9  | KEEP. BANGKA BELITUNG | 0.1057 | 0.1030 | 0.180  | 0.1171 | 0.1265 |
| 10 | KEEP. RIAU            | 0.1009 | 0.1004 | 0.1009 | 0.1017 | 0.1019 |

In Tables 2 and 3, the handling of information is assisted by the matlab 2011b tool in determining the best architectural model with Fletcher-Reeves. The architecture used is 5 models, namely 4-10-1, 4-15-1, 4-20-1, 4-25-1 and 4-30-1. The step-by-step instructions for deciding the best design

model with the Fletcher-Reeves strategy is to determine the minimum error from the training and testing process carried out. In this review, the code parameters used are broken down using the Matlab 2011b application which should be seen in figure 3 below.

| Kode Pelatihan                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Kode Pengujian                                                                                                                                                                                                                                                                                                      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <pre>&gt;&gt; p=[0.1006 0.2869 0.1003 0.5021 0.1369 0.6395 0.1002 0.9000 0.1075 0.1061; 0.1013 0.1010 0.1001 0.3427 0.2694 0.2555 0.1002 0.8509 0.1067 0.1044; 0.1011 0.1009 0.1001 0.2501 0.2558 0.3037 0.1001 0.8925 0.1027 0.1023; 0.1012 0.2649 0.1000 0.2075 0.1534 0.2527 0.1000 0.8059 0.1067 0.1020]</pre>                                                                                                                                                                                              | <pre>&gt;&gt; p1=[0.1005 0.2809 0.1000 0.2041 0.1730 0.1633 0.1000 0.6023 0.1057 0.1009; 0.1007 0.3469 0.1001 0.1822 0.2580 0.1635 0.1001 0.6920 0.1030 0.1004; 0.1006 0.3629 0.1001 0.2188 0.3422 0.1640 0.1001 0.7200 0.1080 0.1009; 0.1004 0.3524 0.1002 0.2063 0.2730 0.1639 0.1002 0.9000 0.1171 0.1017]</pre> |
| <pre>&gt;&gt; t=[0.1004 0.1011 0.1000 0.1897 0.1500 0.2234 0.1000 0.8175 0.1047 0.1018]</pre>                                                                                                                                                                                                                                                                                                                                                                                                                   | <pre>&gt;&gt; t1=[0.1004 0.3900 0.1001 0.2022 0.2603 0.1522 0.1004 0.7483 0.1265 0.1019]</pre>                                                                                                                                                                                                                      |
| <pre>&gt;&gt; net = newff(minmax(p),[10,1],{'tansig','logsig'},'traincgf');  &gt;&gt; net.IW{1,1} net.LW{2,1} net.b{1} net.b{2}  &gt;&gt; net.trainParam.epochs = 1000; net.trainParam.show = 25; net.trainParam.showCommandLine = 0; net.trainParam.showWindow = 1; net.trainParam.goal = 0; net.trainParam.time = inf; net.trainParam.min_grad = 1e-6; net.trainParam.max_fail = 5; net.trainParam.searchFcn = 'srchcha'  &gt;&gt; net = train(net,p,t)  &gt;&gt; [a,Pf,Af,e,perf] = sim(net,p,[],[],t)</pre> | <pre>&gt;&gt; [a,Pf,Af,e,perf] = sim(net,p1,[],[],t1)</pre>                                                                                                                                                                                                                                                         |

Figure 2. Parameters And Program Code

### 3.2 Ratio of Architectural Models Used

The architectural model used in this study uses input data (input layer) = 4, hidden layers = 10, 15, 20, 25, 30. Output layer = 1. After training and testing information with the 4-10-1 architect model, 4-15-1, 4-20-1, 4-25-1 and 4-30-1 using Matlab 2011b and Microsoft Excel applications, so at that time the best engineering model was 4-15-1 with the lowest Performance/MSE (a little). The lowest Performance/MSE level is 0.005488189 compared to the other 4 models. The correlation of the 5 building models used can be seen in table 4 below.

| No | Architectural Model | Training |        |             |             | Testing |        |          |             |
|----|---------------------|----------|--------|-------------|-------------|---------|--------|----------|-------------|
|    |                     | epoch    | actual | Error       | Performance | epoch   | actual | Error    | Performance |
| 1  | 4-10-1              | 200      | 0.1000 | -<br>0.0008 | 0.000000165 | 200     | 0.098  | 0.00013  | 0.010121605 |
| 2  | 4-15-1              | 15       | 0.066  | -<br>0.1495 | 0.006225211 | 15      | 0.066  | -0.20432 | 0.005488189 |
| 3  | 4-20-1              | 32       | 0.114  | -<br>0.0281 | 0.000714844 | 32      | 0.114  | -0.01396 | 0.008846964 |

| No | Architectural Model | Training |        |        |             | Testing |        |          |             |
|----|---------------------|----------|--------|--------|-------------|---------|--------|----------|-------------|
|    |                     | epoch    | actual | Error  | Performance | epoch   | actual | Error    | Performance |
| 4  | 4-25-1              | 161      | 0.101  | 0.0009 | 0.000000926 | 161     | 0.099  | -0.00066 | 0.018542157 |
| 5  | 4-30-1              | 162      | 0.1    | 0.0002 | 0.000000032 | 162     | 0.1    | 0.000004 | 0.008766778 |

### 3.3 Best Architectural Model (4-15-1)

The best architectural model, namely 4-15-1, obtained the following training results.

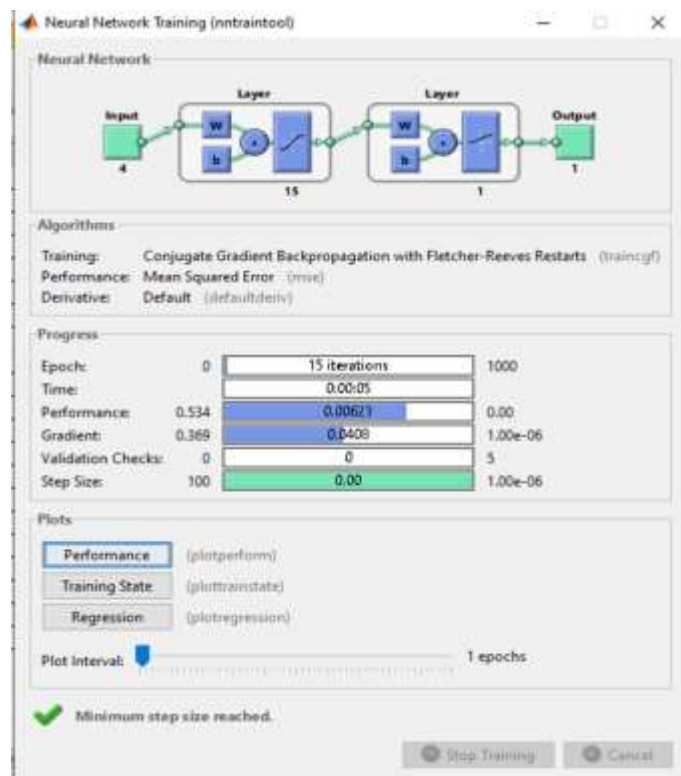


Figure 4. Architectural Model 4-15-1 as best result

From Figure 4, it tends to make sense that training with preparation using the 4-15-1 structure model gives an epoch of 25 iterations, and this model is the best architecture compared to the other 4 models. Tables for training and testing can be seen in table 5 and table 6 below.

Table 5. Architectural Model Training Data 4-15-1

| Pattern | Target (Y1) | Epoch 15 |         |              |
|---------|-------------|----------|---------|--------------|
|         |             | actual   | Error   | SSE          |
| 1       | 0.1004      | 0.067    | 0.0334  | 0.001114662  |
| 2       | 0.1011      | 0.0918   | 0.0093  | 0.0000085713 |
| 3       | 0.1000      | 0.0663   | 0.0337  | 0.001137219  |
| 4       | 0.1897      | 0.3001   | -0.1104 | 0.012181364  |
| 5       | 0.1500      | 0.1923   | -0.0423 | 0.001790627  |
| 6       | 0.2234      | 0.3644   | -0.1410 | 0.019867231  |
| 7       | 0.1000      | 0.0663   | 0.0337  | 0.001135690  |
| 8       | 0.8175      | 0.967    | -0.1495 | 0.022354166  |
| 9       | 0.1047      | 0.0679   | 0.0368  | 0.001353652  |
| 10      | 0.1018      | 0.0667   | 0.0351  | 0.001231783  |

Table 6. Architectural Model Testing Data 4-15-1

| Pattern | Target (Y2) | Epoch 15 |
|---------|-------------|----------|
|---------|-------------|----------|

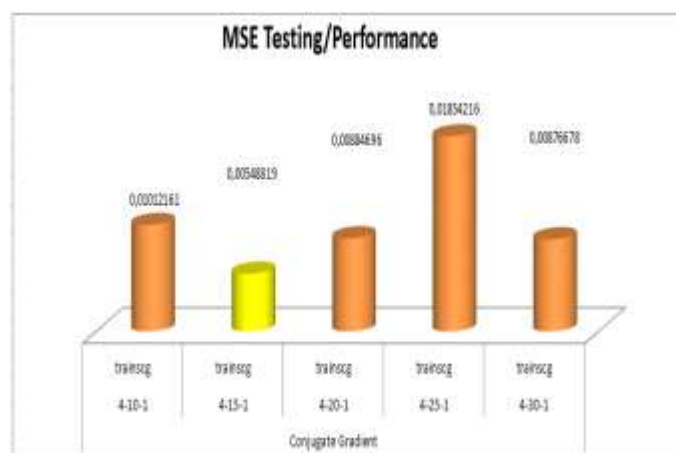
|    |        | actual | Error   | SSE         |
|----|--------|--------|---------|-------------|
| 1  | 0.1004 | 0.0666 | 0.0338  | 0.001144520 |
| 2  | 0.3900 | 0.3655 | 0.0245  | 0.000602466 |
| 3  | 0.1001 | 0.0664 | 0.0337  | 0.001138057 |
| 4  | 0.2022 | 0.156  | 0.0462  | 0.002133849 |
| 5  | 0.2603 | 0.2244 | 0.0359  | 0.001286924 |
| 6  | 0.1522 | 0.1115 | 0.0407  | 0.001660479 |
| 7  | 0.1004 | 0.0664 | 0.0340  | 0.001153349 |
| 8  | 0.7483 | 0.9526 | -0.2043 | 0.041745170 |
| 9  | 0.1265 | 0.0736 | 0.0529  | 0.002800681 |
| 10 | 0.1019 | 0.067  | 0.0349  | 0.001216399 |

### 3.4 Evaluation

After training and testing information on the 4-10-1, 4-15-1, 4-20-1, 4-25-1, 4-30-1 engineering models using Matlab and Microsoft Excel, the architectural model was obtained 4- The best 15-1 with the lowest Performance/MSE Test score is 0.005488189.

**Table 7.** Comparison of Overall Model Results

| Algorithm       | Architecture | Training Function | Epoch (Iteration) | MSE Training | MSE Testing/Performance |
|-----------------|--------------|-------------------|-------------------|--------------|-------------------------|
|                 | 4-10-1       | traincgf          | 200               | 0.00000016   | 0.01012161              |
| Fletcher-Powell | 4-15-1       | traincgf          | 15                | 0.00622521   | 0.00548819              |
| Conjugate       | 4-20-1       | traincgf          | 32                | 0.00071484   | 0.00884696              |
| Gradient        | 4-25-1       | traincgf          | 161               | 0.00000093   | 0.01854216              |
|                 | 4-30-1       | traincgf          | 162               | 0.000000003  | 0.00876678              |



**Figure 5.** MSE Testing / Performance Comparison Chart

## 4. CONCLUSION

Considering the results of the research that has been described and written in this article, it is possible to reason that the Fletcher-Reeves Calculation technique can be used to predict How Much Pineapple Plants Are Production in Sumatra Island as a work to assist public authorities. so that the public authorities on the island of Sumatra have endless great references. it is clear to decide on an approach or to make important progress so that the creation of natural pineapple products on the island of Sumatra does not decline. The method used in making predictions is the Fletcher-Reeves algorithm and is a method in ANN. In this study, the data used was the number of pineapple fruit plants on the island of Sumatra in 2012-2021 obtained from BPS. Given this information, the organizational design model will not be fully defined, including 4-10-1, 4-15-1, 4-20-1, 4-25-1 and 4-30-1. From these 5 models, then Training and Testing was carried out and the best architectural model was obtained, namely 4-15-1 with the least (slight) Performance/MSE test. With the lowest Performance/MSE level of 0.005488189 compared to the other 4 models.

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