SMART DAIRY FARM

Abhishek Anand

Date: 07th March 2023

"Artificial intelligence is not a silver bullet, but it can help us find silver bullets." - Fei-Fei Li

Abstract

Artificial intelligence (AI) is increasingly being used in the dairy industry to improve productivity, efficiency, and animal welfare. AI applications in dairy farming include automated milking systems, precision feeding systems, and cow behavior monitoring systems. These technologies use sensors, data analysis, and machine learning algorithms to optimize milking times, create personalized feeding plans for individual cows, and detect health issues in cows. AI can also help farmers make data-driven decisions about breeding, herd management, and milk production. By using AI, dairy farmers can reduce labor costs, increase milk yields, and improve animal health and welfare. However, the adoption of AI in the dairy industry also presents some challenges, such as the need for specialized skills, high initial costs, and concerns about data privacy and security. Despite these challenges, AI is expected to continue to transform the dairy industry in the years to come.

Problem Statement

How can artificial intelligence be effectively implemented in the dairy industry to improve productivity, efficiency, and animal welfare while addressing the challenges of high initial costs, specialized skills requirements, and data privacy and security concerns?

Some of the problems faced by the Dairy Farmers are :

- Inefficient Milking
- Inaccurate Feeding
- Health Issues
- Breeding Decisions
- Labor costs

In this report we majorly looking cattles as cows and buffaloes.

Assessments

1. Market Need Assessment

The adoption of AI in the dairy industry has grown significantly in recent years due to the benefits it provides. To assess the market need for AI in the dairy industry, we need to consider the following factors:

- ***Growing Demand for Dairy Products:***

The demand for dairy products has been steadily increasing, and this trend is expected to continue. As a result, the dairy industry is under pressure to increase production while maintaining high-quality standards. AI can help farmers optimize their production processes and enhance milk quality, ensuring that they meet the growing demand for dairy products.

- *Increasing Competition:*

The dairy industry is highly competitive, and dairy farmers are constantly looking for ways to gain a competitive advantage. AI can provide this advantage by enhancing production efficiency, reducing costs, improving animal welfare, and enhancing milk quality, ultimately increasing profitability and competitiveness.

- *Labor Shortage:*

The dairy industry is facing a significant labor shortage, and dairy farmers are struggling to find enough workers to perform the necessary tasks. AI can help overcome this challenge by implementing AI-powered robots that can perform tasks such as milking, feeding, and cleaning. This reduces the need for human labor and can help ensure that the farm operates efficiently.

- *Sustainability:*

Sustainability has become a critical factor in the dairy industry, and consumers are increasingly demanding sustainable practices. AI can help farmers implement sustainable practices by reducing feed and water wastage, optimizing production processes, and enhancing animal welfare.

- *Technological Advancements:*

Technological advancements have enabled the development of AI technology, making it more accessible and affordable for dairy farmers. This has led to increased adoption of AI technology in the dairy industry, and it is expected to continue to grow in the future.

2. Customer Need Assessment

To assess the customer need for AI in the dairy industry, we need to consider the following factors:

- *Improved Milk Quality:*

Consumers are increasingly concerned about the quality of the products they consume, and milk is no exception. AI can help farmers optimize milk quality by monitoring cow health, feed quality, and other factors that affect milk quality. By ensuring high-quality milk production, farmers can meet the growing consumer demand for high-quality dairy products.

- *Animal Welfare:*

Animal welfare is a critical factor for consumers when it comes to choosing dairy products. Consumers want to ensure that the animals producing their dairy products are treated humanely and ethically. AI can help improve animal welfare by monitoring the behavior and health of cows, ensuring that they are comfortable, healthy, and happy.

- *Sustainable Practices:*

Consumers are increasingly demanding sustainable practices in all aspects of their lives, and dairy products are no exception. AI can help farmers implement sustainable practices by reducing feed and water wastage, optimizing production processes, and enhancing animal welfare. This can help meet the growing consumer demand for sustainable dairy products.

- *Traceability:*

Consumers are increasingly interested in the origin of the products they consume, and traceability is becoming a critical factor when it comes to choosing dairy products. AI can help farmers track and monitor every aspect of their dairy farm operations, from cow health to milk production, ensuring that the products they produce are traceable and meet the required standards.

- *Cost-Effective Products:*

Consumers are always looking for high-quality products at an affordable price. By implementing AI technology, farmers can optimize their production processes, reduce costs, and ultimately offer cost-effective dairy products to consumers.

3. Business Need Assessment

The dairy industry is constantly evolving, and with the advancements in technology, the adoption of AI in dairy farming has become increasingly popular. To assess the business need of AI in the dairy industry, we need to consider the following factors:

- *Production Efficiency:*

The primary business need for AI in the dairy industry is to enhance production efficiency. The dairy industry is heavily reliant on production efficiency, and any improvements in this area can significantly impact the

profitability of a dairy farm. AI can help farmers monitor and analyze various data points, such as milk production, feed intake, and the behavior of dairy cows, to optimize their dairy farm operations.

- *Cost Reduction:*

Another critical business need for AI in the dairy industry is cost reduction. Dairy farmers face various challenges, including rising feed costs, labor costs, and equipment costs. AI can help farmers reduce costs by optimizing feed intake, reducing wastage, and minimizing labor costs. By implementing AI-powered robots that can perform tasks such as milking, feeding, and cleaning, farmers can reduce the need for human labor and ultimately cut down on labor costs.

- *Animal Welfare:*

Animal welfare is a crucial factor in the dairy industry, and it can directly impact the business. Poor animal welfare can result in decreased milk production and quality, increased veterinary costs, and negative publicity. AI can help improve animal welfare by monitoring the behavior and health of cows, ensuring that they are comfortable, healthy, and happy.

- *Milk Quality:*

The quality of milk produced is a critical factor in the dairy industry, and it can impact the profitability of the farm. AI can help farmers optimize milk quality by analyzing data collected from the farm and identifying factors that affect milk quality, such as feed quality and cow health. By optimizing these factors, farmers can ensure that the milk produced is of high quality and meets the required standards.

- *Profitability:*

The ultimate business need for AI in the dairy industry is to increase profitability. By enhancing production efficiency, reducing costs, improving animal welfare, enhancing milk quality, and increasing revenue, dairy farmers can increase their profits. AI can help dairy farmers gain a competitive advantage, improve their operations, and ultimately increase their profitability.

Target Specifications and Characterizations

The customer characteristics for implementing AI in the dairy industry can be broadly classified into the following categories:

Large-Scale Dairy Farms:

Large-scale dairy farms are one of the primary customers for implementing AI in the dairy industry. These farms typically have a large number of cows, and AI can help manage and monitor the health and well-being of the animals. AI can also help optimize milk production, improve feed efficiency, and reduce labor costs, which are essential for the profitability of large-scale dairy farms.

Technologically Advanced Farms:

Customers who are technologically advanced are more likely to adopt AI technology in their dairy farms. These customers have a better understanding of the potential benefits of AI, and they are more willing to invest in advanced technology to improve their operations. They are also more likely to have the infrastructure required to implement AI technology, such as sensors, cameras, and other monitoring devices.

Farms Focused on Quality:

Customers who are focused on producing high-quality dairy products are more likely to implement AI technology in their farms. AI can help monitor cow health, milk quality, and other factors that affect the quality of dairy products. By ensuring high-quality milk production, farmers can meet the growing consumer demand for high-quality dairy products.

Farms Focused on Sustainability:

Customers who are focused on sustainability are also likely to adopt AI technology in their dairy farms. AI can help farmers implement sustainable practices by reducing feed and water wastage, optimizing production processes, and enhancing animal welfare. This can help meet the growing consumer demand for sustainable dairy products.

Farms Focused on Traceability:

Customers who are focused on traceability are more likely to adopt AI technology in their dairy farms. AI can help farmers track and monitor every aspect of their dairy farm operations, from cow health to milk production, ensuring that the products they produce are traceable and meet the required standards.

External Search

For building ML model, I have taken the data from Kaggle:

Health Monitoring of Cows using Machine Learning:

- (https://www.kaggle.com/datasets/shivamagarwal29/cow-lumpy-disease-dataset)

Milk Quality Prediction of cows:

- (https://www.kaggle.com/datasets/cpluzshrijayan/milkquality)

Some are the Research papers related to this field:

Calving / Pregnancy information:

- (https://www.sciencedirect.com/science/article/pii/S0022030217304113?via%3Dihub)
- (https://reader.elsevier.com/reader/sd/pii/S0167587720309211?token=D21BF63A78623FD63ACB6C26AD8E76A11378FD3391E147666512585ACEA9B04CF023CBAE1DB496DFB39E1BCFDCFBADB5&originRegion=eu-west-1&originCreation=20230228192650) ***This** research paper contains various applications of machine learning to improve dairy farm management.

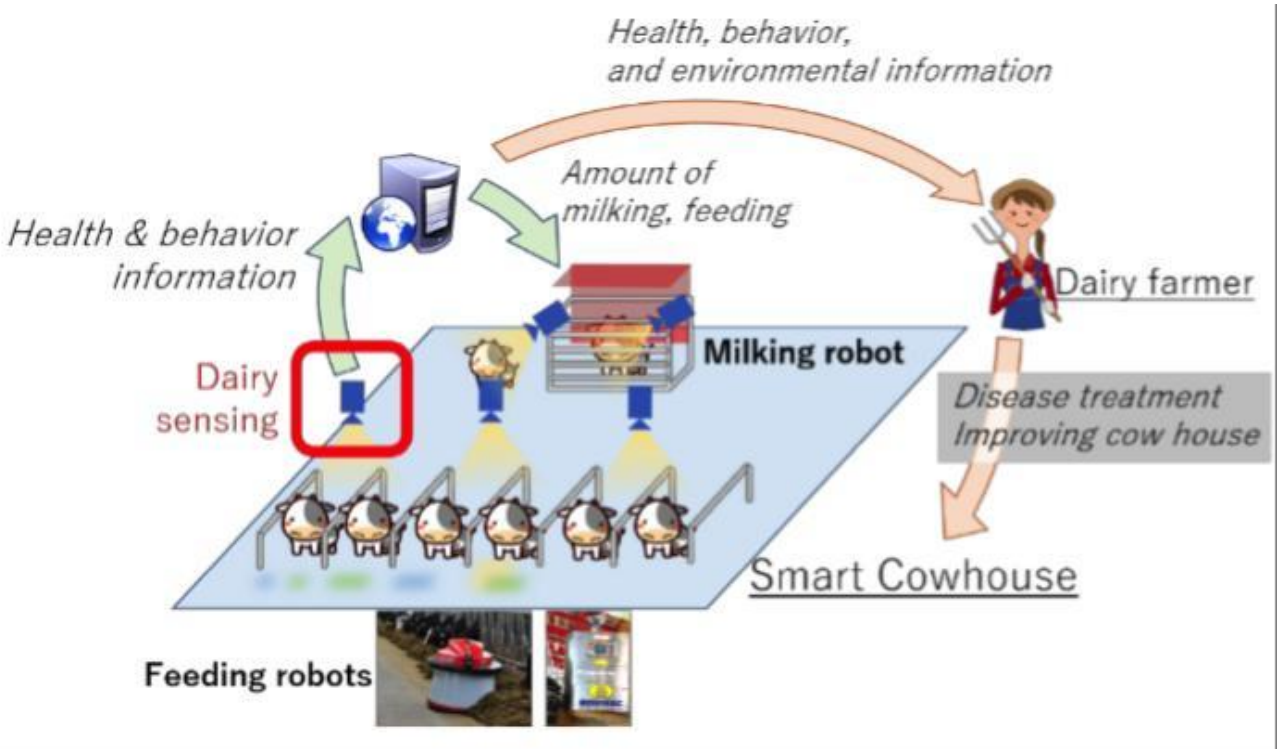
Digital Identity:

Cattle in a lot of countries, including EU countries, the UK and the US, have "cattle passports," which authorities use to track infectious disease outbreaks, ensure the effective rollout of government schemes, and make insurance claims. In practice, this means that many cattle are identified by tags punched into their ears. Not only are these tags painful for the animals, but are unreliable as well. In some developing countries, including India, farmers cut the cattle's ears to commit identity fraud and make fraudulent insurance claims.

Cattle facial recognition, which is also called the Aadhar of cattle in India, is the perfect solution for this cattle identity problem. It is also a technically validated solution, thanks to the recent advancements in machine vision

AI-Powered Image Analysis Could Transform Dairy Farming:

- https://www.photonics.com/Articles/AI-Powered_Image_Analysis_Could_Transform_Dairy/a62229

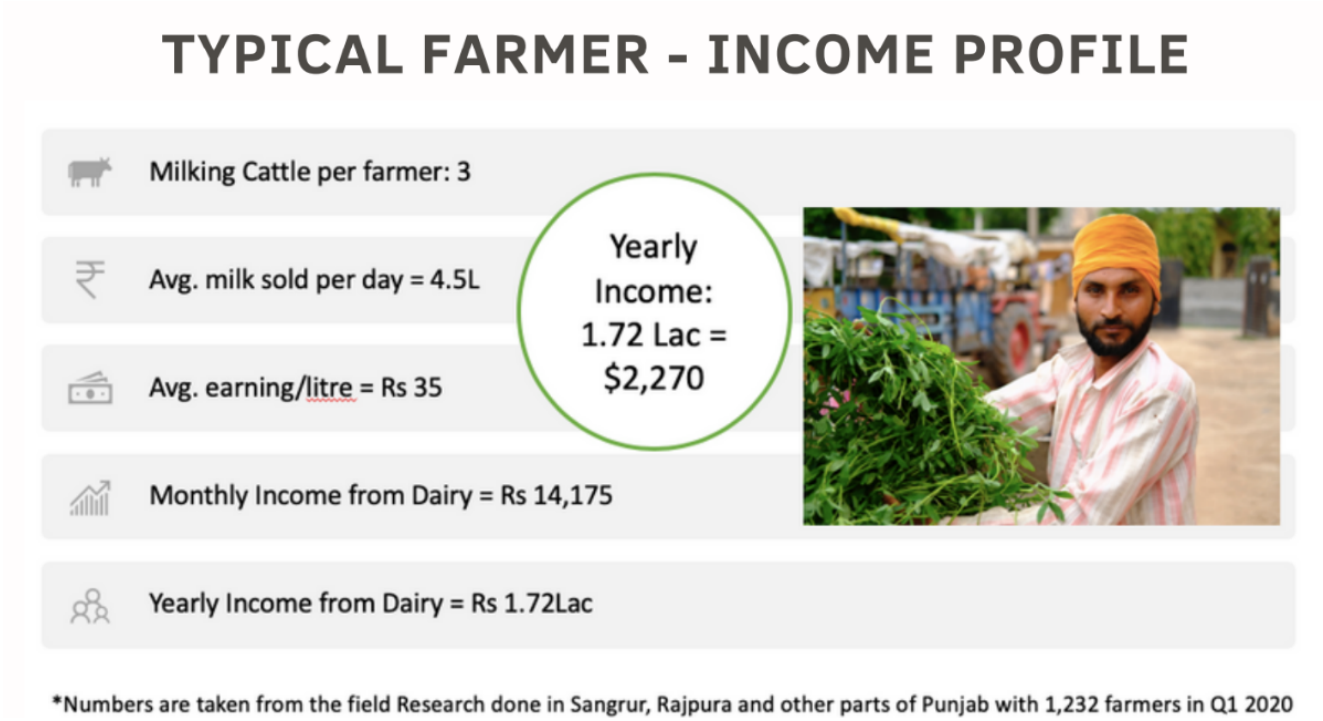


Artificial Intelligence Applied to a Robotic Dairy Farm to Model Milk Productivity and Quality based on Cow Data and Daily Environmental Parameters:

(https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7285505/)

Benchmarking alternate products

MoooFarm, an AgriTech start-up with the mission statement "to make farmers prosperous," is working to produce the technology at scale and work with the government to build a robust cattle identity mechanism. This technology can become the foundation of multiple auxiliary services like cattle insurance, cattle loans and government subsidies. Other companies including **Cainthus**, **Techvantage's Moo-ID**, and **Stellapps**, are also working to roll out a market-ready version of this product. Below is the MoooFarm profile for dairy farmers, which shows all the information related to cattles.



Applicable Patents

- Dairy technology start-up, Stellapps Technologies Pvt Ltd, has been granted a 20-year patent for its invention – farm and herd management system, which helps dairy stakeholders to remotely monitor and manage their farms through mobile devices.

Applicable Regulations

In general, governments around the world are increasingly recognizing the potential benefits and risks associated with the use of AI and are actively developing policies and regulations to govern its use. In the context of dairy industries, some potential regulatory considerations may include:

- *Data privacy and security:* Dairy industry operators may need to comply with regulations related to the collection, storage, and use of customer and production data, particularly if AI systems are used to analyze this data.

- *Ethical considerations:* The use of AI in the dairy industry may raise ethical concerns, particularly in relation to animal welfare and the impact on human workers. Governments may develop guidelines or regulations to ensure that the use of AI in this industry is ethical and transparent.

- *Safety and quality standards:* The use of AI in the dairy industry may have implications for the safety and quality of dairy products. Governments may establish regulations to ensure that AI systems used in dairy production are reliable and accurate, and that they do not compromise the safety or quality of dairy products.

- *Liability:* As AI systems become more sophisticated and autonomous, there may be questions around who is responsible in the event of errors

or accidents. Governments may develop regulations to clarify liability in these cases.

These are just some potential regulatory considerations related to the use of AI in dairy industries.

Applicable Constraints

There are several constraints that may need to be considered when implementing AI in dairy industries. Some of these constraints may include:

Data quality: AI systems require large amounts of high-quality data to be trained effectively. However, dairy industry data may be complex and variable, and may require significant preprocessing to be useful for AI applications. Ensuring the quality and quantity of data may be a constraint for implementing AI in dairy industries.

Cost: Implementing AI systems can be costly, particularly if the dairy industry does not have the necessary infrastructure or resources in place to support them. The cost of hardware, software, and personnel may be a constraint for some dairy industry operators.

Compatibility with existing systems: Many dairy industry operators may already have existing systems in place that are not compatible with AI systems. Integrating AI with existing systems may require additional development and customization, which can be costly and time-consuming.

Regulatory compliance: As mentioned earlier, governments may have regulations and guidelines in place for the use of AI in the dairy industry. Dairy industry operators may need to ensure compliance with these regulations, which can also be a constraint for implementing AI.

Skilled personnel: Developing and implementing AI systems requires specialized skills and expertise. Finding and retaining personnel with the necessary skills may be a constraint for some dairy industry operators.

Ethical considerations: The use of AI in the dairy industry may raise ethical concerns, particularly in relation to animal welfare and the impact on human workers. Dairy industry operators may need to consider ethical implications when implementing AI systems.

Business Model

The business model of implementing AI in dairy farms can vary depending on the specific application and context. However, some potential business models for implementing AI in dairy farms could include:

- Increased efficiency and productivity: One potential business model for implementing AI in dairy farms is to use AI systems to improve efficiency and productivity. For example, AI systems could be used to optimize feed and water consumption, predict milk yield, or identify health issues in cows. This could help dairy farmers save costs and increase productivity, leading to increased profits.

- Precision agriculture: Another potential business model for implementing AI in dairy farms is precision agriculture. AI systems could be used to collect and analyze data on soil quality, weather patterns, and other environmental factors to optimize crop production, which could in turn benefit dairy farms that rely on these crops for feed.

- Data-driven decision making: AI systems can help dairy farmers make data-driven decisions, such as when to breed cows, which cows to cull, or how much feed to provide. By using data to inform decisions, dairy farmers can make more informed choices that could improve their bottom line.

- Value-added services: AI systems can also be used to provide value-added services to dairy farmers, such as predicting milk prices, optimizing logistics and transportation, or identifying market trends. By providing these services, dairy farmers could potentially increase revenue and profitability.

- Environmental sustainability: Another potential business model for implementing AI in dairy farms is to use AI systems to improve environmental sustainability. For example, AI systems could be used to optimize manure management, reduce greenhouse gas emissions, or

improve water quality. This could help dairy farmers meet regulatory requirements, reduce costs, and improve their reputation.

These are just a few potential business models for implementing AI in dairy farms. The specific business model will depend on the specific application of AI, the size and scale of the dairy farm, and the broader economic and regulatory context.

Concept Generation and Concept Development

Basically the main areas of interest in dairy farms are caring for the cattles health, producing good quality milk, producing good quality fodder for cattles, predicting pregnancy/calving period of cattles. These can be easily solved using AI. Here I am taking one of the examples and building an ML model for this. For this We can also build a portable IoT device using various types of sensors like pH sensors, Turbidity sensors etc, which can be useful for the Dairy Farmers so that they can measure the pH level, turbidity etc. In this IoT device we feed the output data from different sensors and record the measurements for different features, then we feed this data to our ML model to predict the quality of the Milk.

Turbidity Sensor

pH Sensor

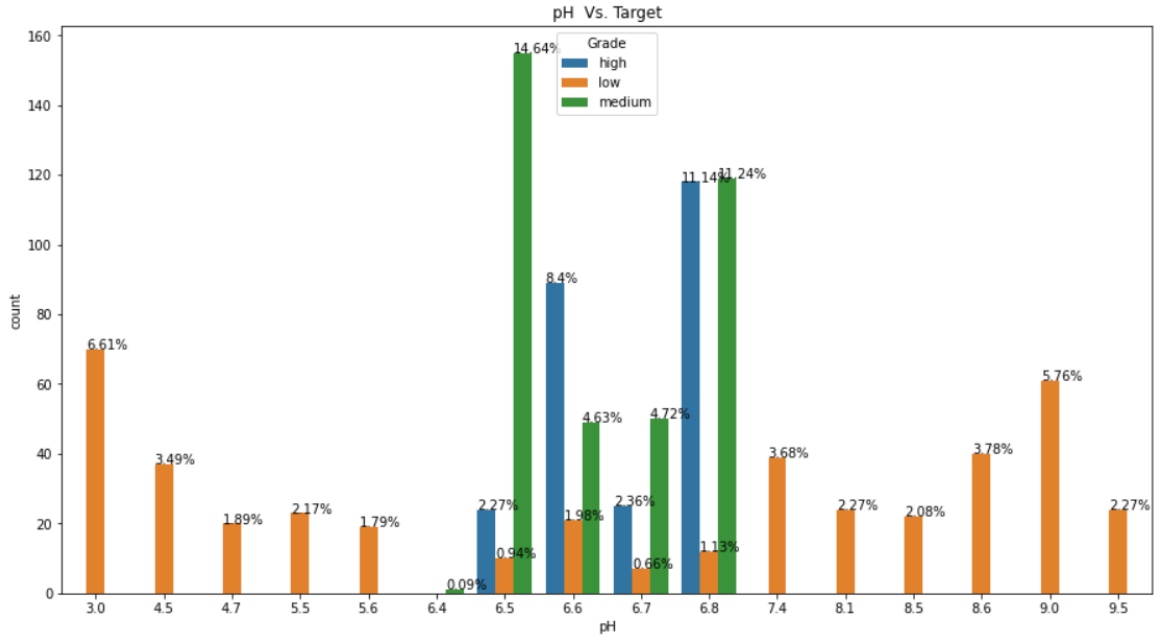
Now we come to the building of the ML model. I have taken a dataset from **Kaggle**, and then I performed exploratory analysis on the datasets, then checked various types of ML Classifier for the prediction of milk quality.

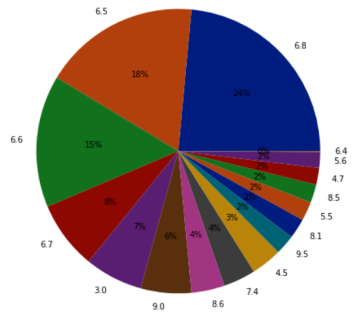
Simple ML modelling for the prediction of Milk Quality

In [1]:
```
import numpy as np
import pandas as pd
df = pd.read_csv('milknew.csv')
df.head()
```

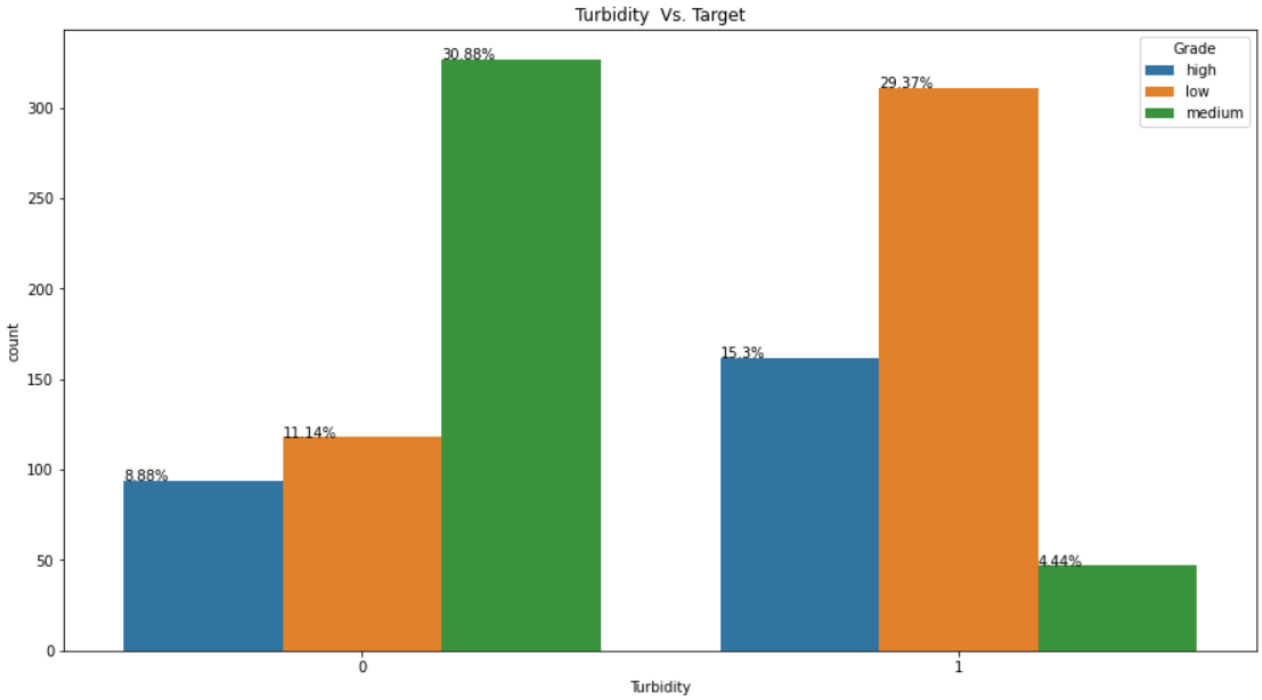
Out[1]:

	pH	Temprature	Taste	Odor	Fat	Turbidity	Colour	Grade
0	6.6	35	1	0	1	0	254	high
1	6.6	36	0	1	0	1	253	high
2	8.5	70	1	1	1	1	246	low
3	9.5	34	1	1	0	1	255	low
4	6.6	37	0	0	0	0	255	medium





- Good Quality in pH range 6.4 to 6.8
- 6.5 ph shown highest HIGH quality & 6.4 being lowest



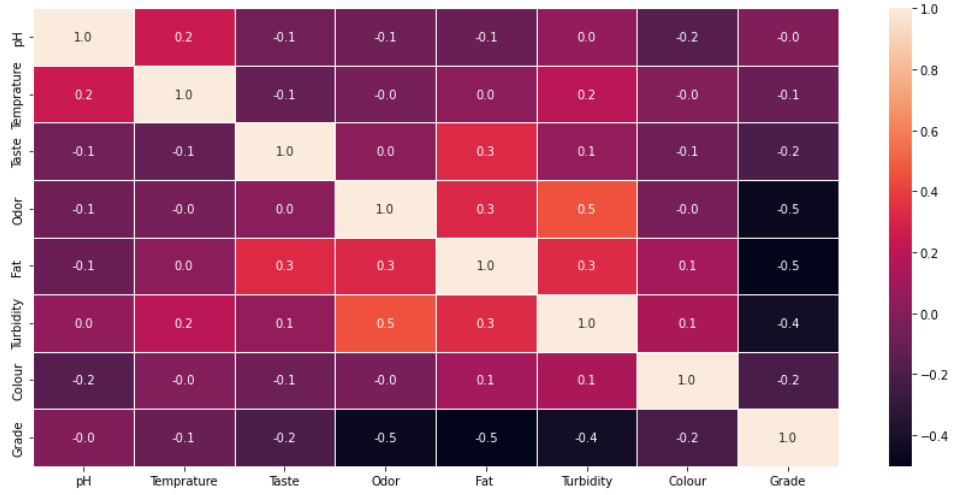
Feature Engineering

In [23]:
```
from sklearn.preprocessing import StandardScaler,LabelEncoder,LabelBinarizer
le = LabelEncoder()
target = le.fit_transform(df.Grade)
map_dict = dict(zip(target,df.Grade))
df.Grade = target
```

Finding Correlation

In [24]:
```
plt.figure(figsize=(15,7))
data = df.corr()
sns.heatmap(data,annot=True,fmt='.1f',linewidths=0.5)
```

Out[24]: <AxesSubplot:>



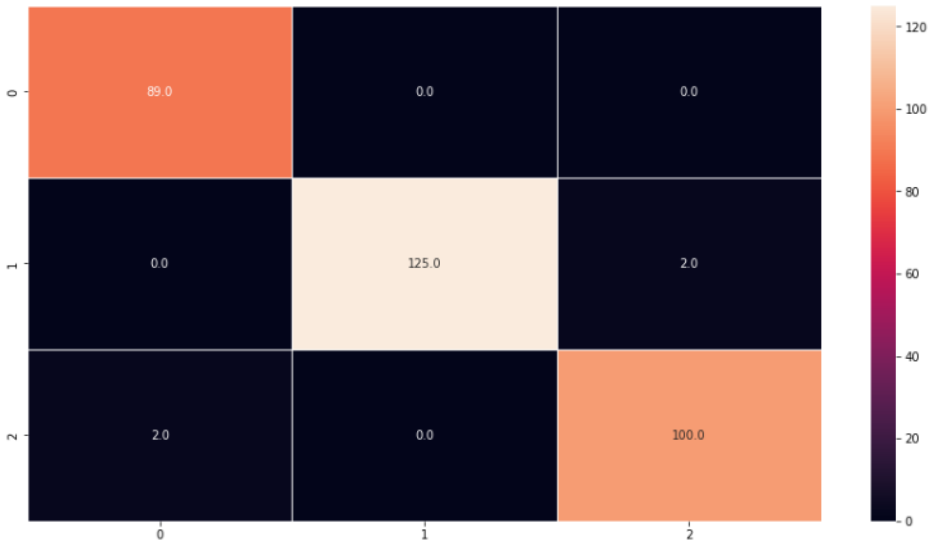
In [25]:
```
#Odor,Fat,Turbudity,Colour & Taste Are important to Classify grade
#pH and Temperature show less covariance
```

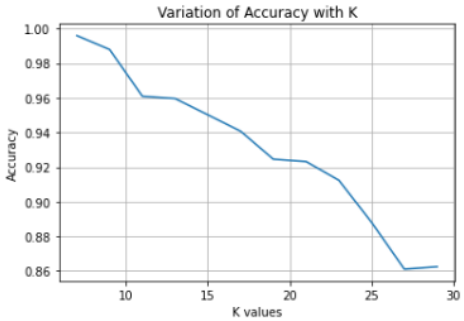
We will now select various ML models and then see how different model gives different accuracy:

KNN:

```
In [34]: KNN(x_train,y_train,x_test,y_test,N=None,plot=True,show_knn_graph=True)
```

```
Best K value: 7
Model accuracy with k=7 is : 0.9874213836477987
```





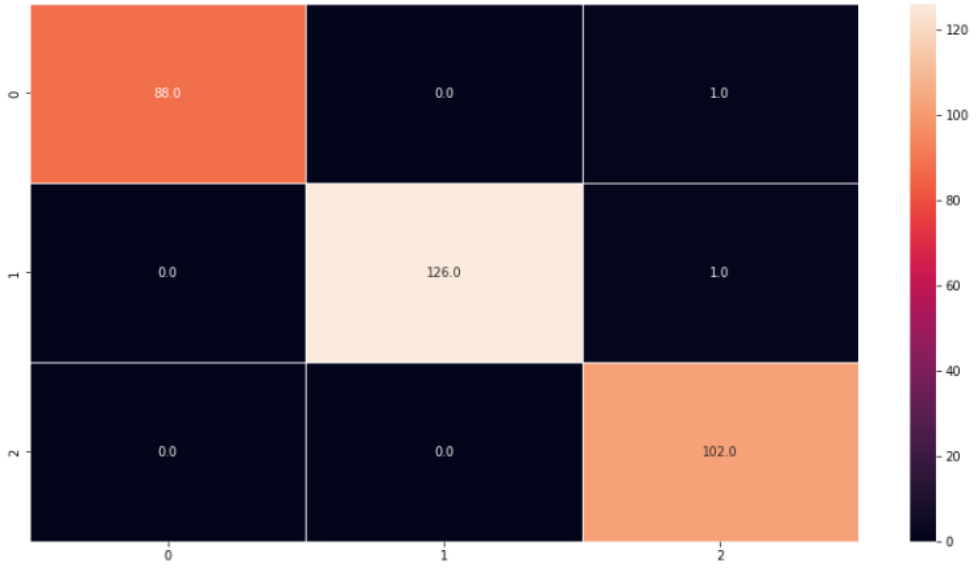
Random Forest Classifier:

In [35]:
```
# Implying Random Forest Classifier
```

In [36]:
```
def RFC(x_train,y_train,x_test,y_test,plot=True):
    model = RandomForestClassifier()
    model.fit(x_train,y_train)
    pred = model.predict(x_test)
    print('Model Accuracy = ',accuracy_score(y_test,pred))
    cm = confusion_matrix(y_test,pred)
    if plot:
        plt.figure(figsize=(15,8))
        ax = sns.heatmap(cm,annot=True,linewidths=0.5,fmt=".1f")
        plt.show()
    else:
        print('Confusion matrix: \n',cm)
```

In [37]:
```
RFC(x_train,y_train,x_test,y_test)
```

```
Model Accuracy =  0.9937106918238994
```



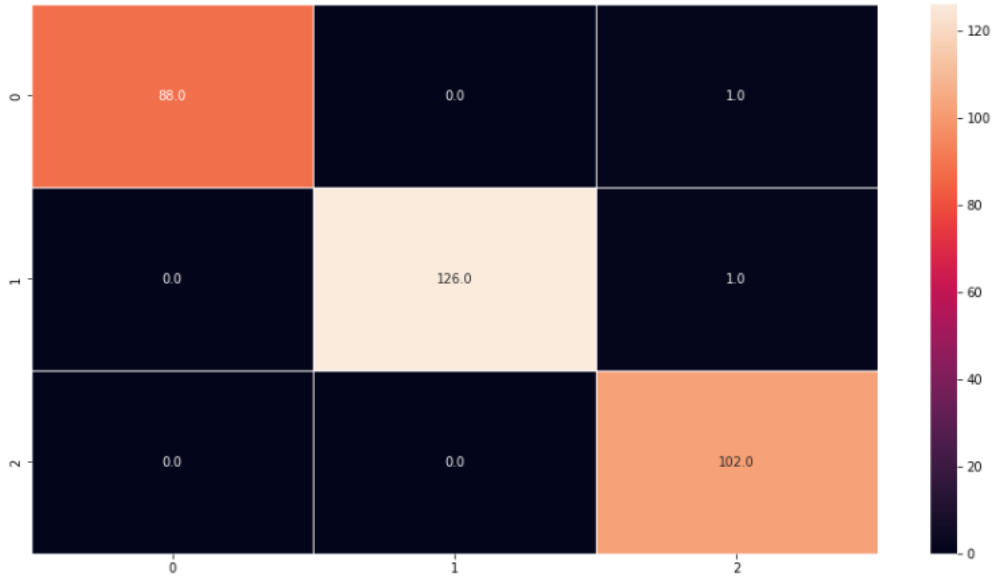
XGBoost:

In [38]:
```
# Implying XGBoost Classifier
```

In [39]:
```
def XGB(x_train,y_train,x_test,y_test,plot=True):
    model = XGBClassifier()
    model.fit(x_train,y_train)
    pred = model.predict(x_test)
    print('Model Accuracy = ',accuracy_score(y_test,pred))
    cm = confusion_matrix(y_test,pred)
    if plot:
        plt.figure(figsize=(15,8))
        ax = sns.heatmap(cm,annot=True,linewidths=0.5,fmt=".1f")
        plt.show()
    else:
        print('Confusion matrix: \n',cm)
```

In [40]:
```
XGB(x_train,y_train,x_test,y_test)
```

```
Model Accuracy =  0.9937106918238994
```



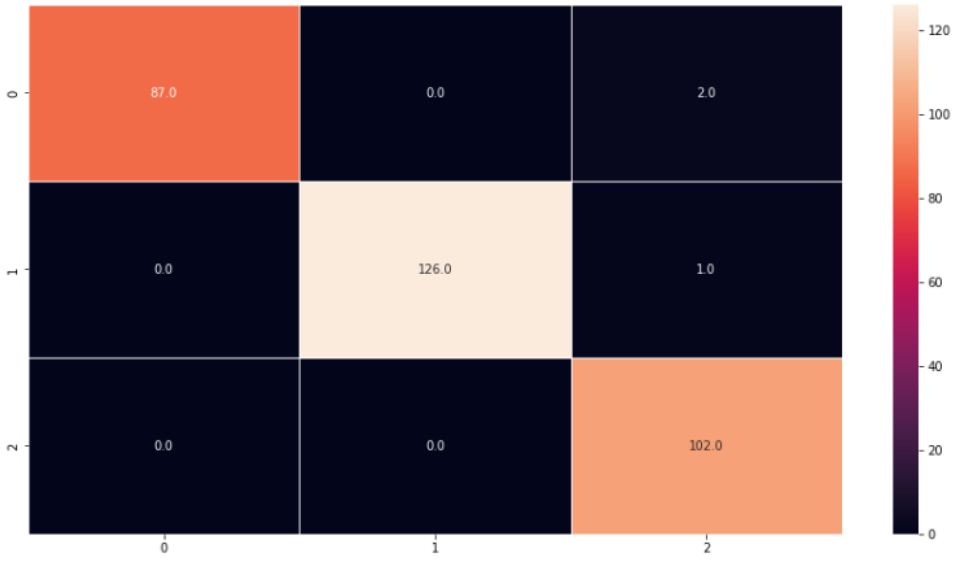
Decision Tree:

In [41]:
```
# Implysing Decision Tree Classifier
```

In [42]:
```
def DT(x_train,y_train,x_test,y_test,plot=True):
    model = DecisionTreeClassifier()
    model.fit(x_train,y_train)
    pred = model.predict(x_test)
    print('Model Accuracy = ',accuracy_score(y_test,pred))
    cm = confusion_matrix(y_test,pred)
    if plot:
        plt.figure(figsize=(15,8))
        ax = sns.heatmap(cm,annot=True,linewidths=0.5,fmt=".1f")
        plt.show()
    else:
        print('Confusion matrix: \n',cm)
```

In [43]:
```
DT(x_train,y_train,x_test,y_test)
```

```
Model Accuracy =  0.9905660377358491
```



NOW WE CHECKING ACCURACY WITH SELECTED FEATURES FOR ALL MODELS:

Random Forest Classifier:

```
In [44]: # For Random Forest Classifier

In [45]: for i in range(2,8):
             x_new = SelectKBest(chi2,k=i).fit_transform(X,y)
             print('WITH {} SELECTED FEATURES\n'.format(i))
             x_train,x_test,y_train,y_test=train_test_split(x_new,y,test_size=0.3)
             RFC(x_train,y_train,x_test,y_test,plot=False)

WITH 2 SELECTED FEATURES

Model Accuracy =  0.7547169811320755
Confusion matrix:
 [[ 39  15  27]
 [ 10 104  11]
 [ 11   4  97]]
WITH 3 SELECTED FEATURES

Model Accuracy =  0.839622641509434
Confusion matrix:
 [[ 43   7  20]
 [  7 112  16]
 [  1   0 112]]
WITH 4 SELECTED FEATURES

Model Accuracy =  0.9088050314465409
Confusion matrix:
 [[ 68  15   5]
 [  2 116   0]
 [  5   2 105]]
WITH 5 SELECTED FEATURES

Model Accuracy =  0.9025157232704403
Confusion matrix:
 [[ 68   9   7]
 [  6 112   0]
 [  7   2 107]]
WITH 6 SELECTED FEATURES

Model Accuracy =  0.89937106918239
Confusion matrix:
 [[ 63   7   0]
 [  7 123   0]
 [ 18   0 100]]
WITH 7 SELECTED FEATURES

Model Accuracy =  0.9968553459119497
Confusion matrix:
 [[ 65   0   0]
 [  1 124   0]
 [  0   0 128]]
```

XGBoost:

In [46]:
```
# For XGBoost
```

In [47]:
```
for i in range(2,8):
    x_new = SelectKBest(chi2,k=i).fit_transform(X,y)
    print('WITH {} SELECTED FEATURES\n'.format(i))
    x_train,x_test,y_train,y_test=train_test_split(x_new,y,test_size=0.3)
    XGB(x_train,y_train,x_test,y_test,plot=False)
```

```
WITH 2 SELECTED FEATURES

Model Accuracy =  0.7767295597484277
Confusion matrix:
 [[ 39   8  22]
 [ 12 102  13]
 [ 11   5 106]]
WITH 3 SELECTED FEATURES

Model Accuracy =  0.8333333333333334
Confusion matrix:
 [[ 42  16  22]
 [  1 109  13]
 [  0   1 114]]
WITH 4 SELECTED FEATURES

Model Accuracy =  0.8553459119496856
Confusion matrix:
 [[ 57  10   8]
 [ 18 127   0]
 [  9   1  88]]
WITH 5 SELECTED FEATURES

Model Accuracy =  0.89937106918239
Confusion matrix:
 [[ 65   9   1]
 [ 10 112   0]
 [ 11   1 109]]
WITH 6 SELECTED FEATURES

Model Accuracy =  0.8836477987421384
Confusion matrix:
 [[ 67  12   0]
 [  7 124   0]
 [ 16   2  90]]
WITH 7 SELECTED FEATURES

Model Accuracy =  1.0
Confusion matrix:
 [[ 74   0   0]
 [  0 124   0]
 [  0   0 120]]
```

Decision Tree Classifier:

In [48]:
```
# For Decision Tree Classifier
```

In [49]:
```
for i in range(2,8):
    x_new = SelectKBest(chi2,k=i).fit_transform(X,y)
    print('WITH {} SELECTED FEATURES\n'.format(i))
    x_train,x_test,y_train,y_test=train_test_split(x_new,y,test_size=0.3)
    DT(x_train,y_train,x_test,y_test,plot=False)
```

```
WITH 2 SELECTED FEATURES

Model Accuracy =  0.8207547169811321
Confusion matrix:
 [[ 36   8  17]
 [ 11 122  15]
 [  4   2 103]]
WITH 3 SELECTED FEATURES

Model Accuracy =  0.8050314465408805
Confusion matrix:
 [[ 49  13  22]
 [  9 100  17]
 [  1   0 107]]
WITH 4 SELECTED FEATURES

Model Accuracy =  0.8930817610062893
Confusion matrix:
 [[ 72   7   0]
 [ 14 119   0]
 [ 11   2  93]]
WITH 5 SELECTED FEATURES

Model Accuracy =  0.9056603773584906
Confusion matrix:
 [[ 83   7   0]
 [  4 108   0]
 [ 15   4  97]]
WITH 6 SELECTED FEATURES

Model Accuracy =  0.9088050314465409
Confusion matrix:
 [[ 53   8   5]
 [  9 131   0]
 [  7   0 105]]
WITH 7 SELECTED FEATURES

Model Accuracy =  1.0
Confusion matrix:
 [[ 69   0   0]
 [  0 141   0]
 [  0   0 108]]
```

KNN:

In [50]:
```
# For KNN
```

In [51]:
```
for i in range(2,8):
    x_new = SelectKBest(chi2,k=i).fit_transform(X,y)
    print('WITH {} SELECTED FEATURES\n'.format(i))
    x_train,x_test,y_train,y_test=train_test_split(x_new,y,test_size=0.3)
    KNN(x_train,y_train,x_test,y_test,plot=False)
```

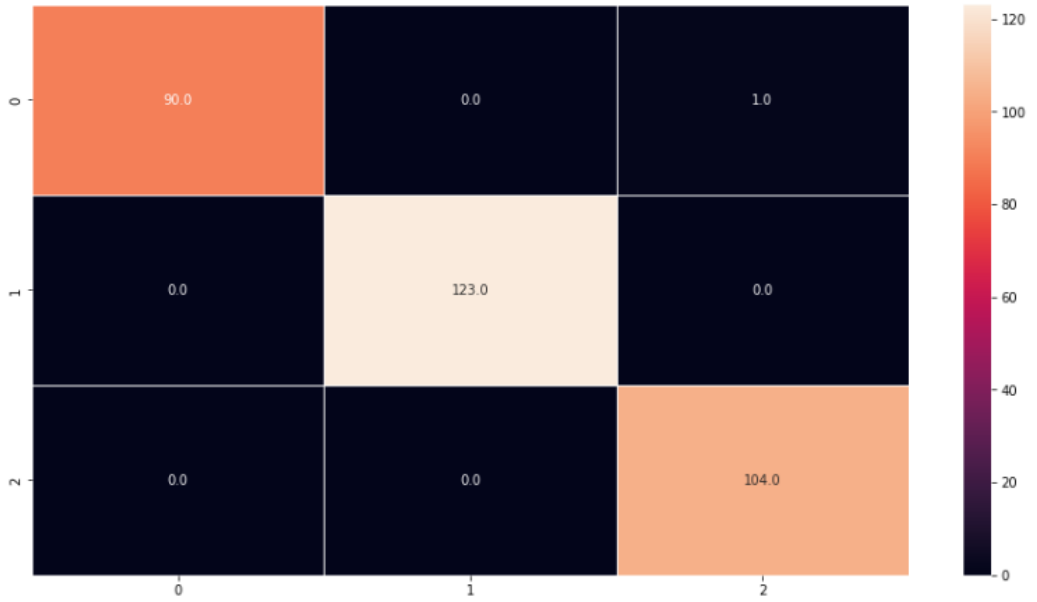
```
WITH 2 SELECTED FEATURES

Best K value: 15
Model accuracy with k=15 is : 0.7547169811320755
Confusion matrix:
 [[ 44  10  29]
 [ 13 107  11]
 [ 11   4  89]]
WITH 3 SELECTED FEATURES

Best K value: 13
Model accuracy with k=13 is : 0.7987421383647799
Confusion matrix:
 [[ 45  12  24]
 [  7  97  20]
 [  0   1 112]]
WITH 4 SELECTED FEATURES

Best K value: 3
Model accuracy with k=3 is : 0.8553459119496856
Confusion matrix:
 [[ 53  23   7]
 [  7 109   0]
 [  0   9 110]]
WITH 5 SELECTED FEATURES

Best K value: 3
Model accuracy with k=3 is : 0.8805031446540881
Confusion matrix:
 [[ 52   9  16]
 [  1 110   6]
 [  0   6 118]]
WITH 6 SELECTED FEATURES

Best K value: 9
Model accuracy with k=9 is : 0.8773584905660378
Confusion matrix:
 [[ 54   9  18]
 [  0 113   9]
 [  2   1 112]]
WITH 7 SELECTED FEATURES

Best K value: 1
Model accuracy with k=1 is : 0.9905660377358491
Confusion matrix:
 [[ 89   0   2]
 [  0 123   0]
 [  1   0 103]]
```

Now Decision Tree and XGBoost comes with the greatest accuracy, then we perform gridsearch to both of them:

PERFORM GRIDSEARCH ON DECISION TREE

In [52]:
```
param_grid = {'max_features': ['auto', 'sqrt', 'log2'],
              'ccp_alpha': [0.1, .01, .001],
              'max_depth' : [5, 6, 7, 8, 9],
              'criterion' :['gini', 'entropy']
             }
dt = DecisionTreeClassifier(random_state=1024)
dt_grid = GridSearchCV(estimator=dt, param_grid=param_grid, cv=5, verbose=True)
dt_grid.fit(x_train, y_train)
pred = dt_grid.predict(x_test)
print('Model Accuracy = ',accuracy_score(y_test,pred))
cm = confusion_matrix(y_test,pred)
plt.figure(figsize=(15,8))
ax = sns.heatmap(cm,annot=True,linewidths=0.5,fmt=".1f")
plt.show()
```

```
Fitting 5 folds for each of 90 candidates, totalling 450 fits
Model Accuracy =  0.9968553459119497
```



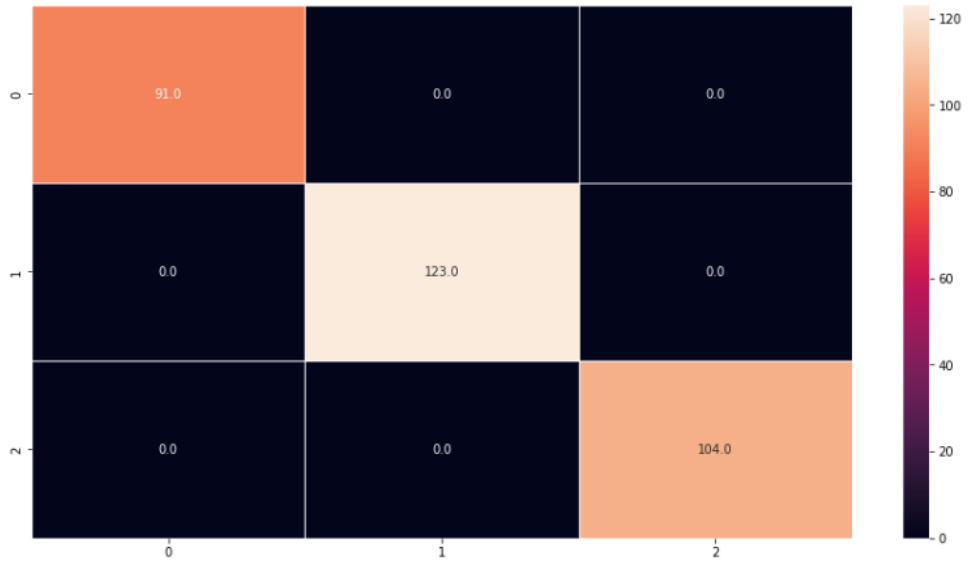
XGBCLASSIFIER WITH GRIDSEARCH

In [53]:
```
parameters = {
    'max_depth': range (2, 10, 1),
    'n_estimators': range(60, 220, 40),
    'learning_rate': [0.1, 0.01, 0.05]
}
grid_xgb = GridSearchCV(
    estimator=XGBClassifier(),
    param_grid=parameters,
    scoring = 'accuracy',
    n_jobs = -1,
    cv = 10,
    verbose=True
)
grid_xgb.fit(x_train, y_train)
pred = grid_xgb.predict(x_test)
```

```
Fitting 10 folds for each of 96 candidates, totalling 960 fits
```

In [54]:
```
print('Model Accuracy = ',accuracy_score(y_test,pred))
cm = confusion_matrix(y_test,pred)
plt.figure(figsize=(15,8))
ax = sns.heatmap(cm,annot=True,linewidths=0.5,fmt=".1f")
plt.show()
```

```
Model Accuracy =  1.0
```

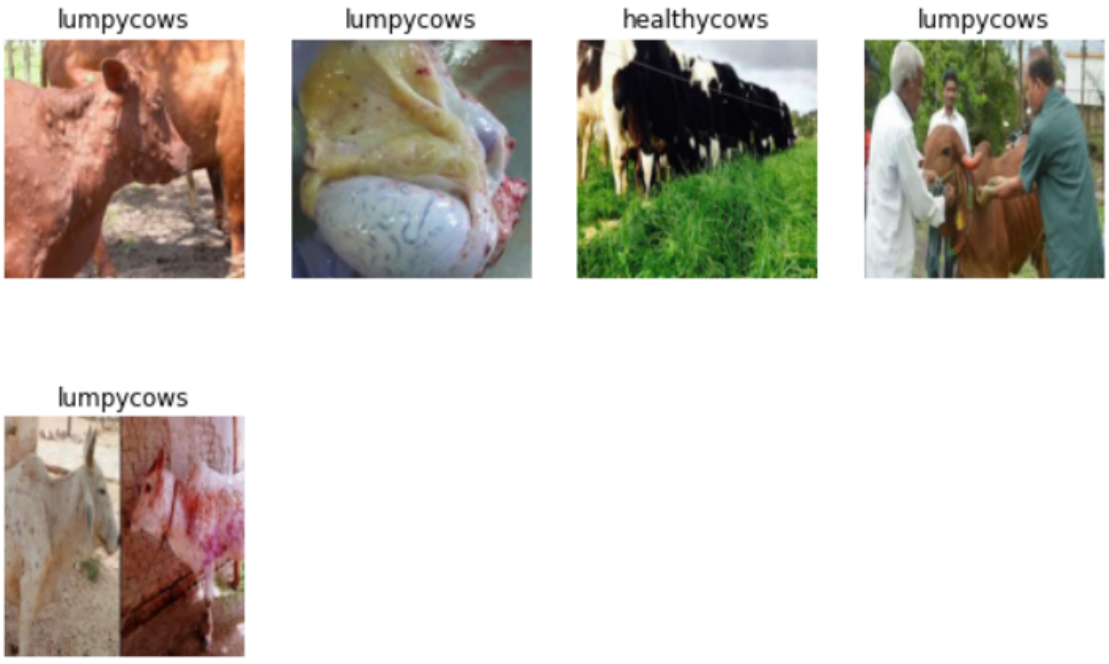


Then from here we finalize the XGBoost model, because of its 100% accuracy.

So this is all about Milk Quality prediction, and then we also build an Application for classifying the disease in the cows, and we implement an ML model for this. Here I am just giving the idea for ML model for classification of diseases in Cows:

Here I am inserting some images of ML model , someone already built this:

```
for image_batch, labels_batch in dataset.take(1):
    for i in range(5):
        ax = plt.subplot(3, 4, i + 1)
        plt.imshow(image_batch[i].numpy().astype("uint8"))
        plt.title(class_names[labels_batch[i]])
        plt.axis("off")
```



We can build an application for this also, So this is all about Cow's disease classification.

Final Product Prototype

For Final product, we have to supply some of the below services:

1. An IoT device to measure the quality of milk. In this the dairy farmers just dip this device into the container full of milk and then , the sensors take all the measurements which is our input data from the milk, and then it feeds the data into the ML model inside it, and performs the prediction of the quality of milk.
2. A Mobile Application, for the detection of disease in cows, by which farmers scan their cattles and then the application takes that input image and feeds it to the ML model inside it, and then gives the correct output after classification.
3. A Mobile Application, for the prediction of the calving period of the cows, by which farmers fill some of the health features of their cattles like temperatures and then the application takes that input data and feeds it to the ML model inside it, and then gives the correct information about the calving period of the cattles.
4. An application with Insight Dashboard for all the data of production of milk in years or months, also all the sales data, customers data, location data, basically that application will do the customer churning for dairy market.
5. A fully implemented mobile application which contains all the information about the food of cattles, which also gives the insight for when to feed the cattle , and in how much, so the production is high, this all can be implemented through ML model.

References:

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[1] Thank you