6.1. Overview

Crop yield forecasts provide important information for government agencies, commodity traders, producers and other users in planning harvest, storage, transportation and marketing activities. Yield estimates of several crops in study area are currently based on field surveys and farmer interviews although official forecasts do not exist for many crops. This methodology is expensive and time-consuming.

Remote sensing is a promising alternative approach. The satellite data as part of a crop yield estimation system can be considered a natural component because of the ability of satellites to provide relatively economical, consistent and repeated coverage over large areas. These characteristics of satellites allow collecting data useful for timely estimation of crop conditions throughout an entire growing season covering either important agricultural production regions or remote regions where accurate information is normally unavailable. Thus, remote sensing is a potential alternative to previous data collection methods. This approach would be attractive because yields could potentially be forecast at lower cost, with greater accuracy and longer lead times.

Estimation crop yield before the harvest is one of the greatest concerns in agriculture since variations in crop yield from year to year impact international trade, food supply, and market prices (Hayes and Decker 1998). Early prediction of crop yield on the global and regional scales offers useful information to policy planners. Appropriate recognition of crop productivity is essential for sound land use planning and economic policy (Hayes and Decker 1996). At the field-scale, crop yield information helps farmers make quick decisions for upcoming situations, such as the choice of alternative crops and whether to abandon a crop at an early stage of growth. More recently, assessment of crop productivity at the within-field level has become an important issue in precision farming (Stafford 2000; Yang et al., 2001a). Describing the within-field variability of crop yield on a real-time basis offers precious information for VRTs (Stafford, 2000; Yang et al., 2001a). In Iran, yield forecasting, or determining yield is done in advance of harvest and it is important for determining import-export policies, government aid for farmers, and allocation of subsidence for regional agricultural programs.
6.2. Importance of Agricultural sector in the study area

Agricultural sector plays a very significant role in the economic activities in the region. The majority of working population is busy working in the agricultural sector (49.57%). The comparison of working population in this sector in the study region with that of Malayer and Hamadan Province and the country reveals the significant position of agricultural sector in the region. In facts (49.57%) the entire residing working population in different rural areas in the region under study are farmers (The index for Malayer, Hamadan Province, and the whole country is 28.6%, 54.2% and 49.75% respectively).

On the other hand, agriculture as the main activity serves as a very important factor in the economy of the region under study. Of the activities related to agriculture and its sub-branches, cultivation is the most important agricultural activity that is directed in two methods of dry-farming and irrigational farming. The surface under cultivation in the area is 13,400 hectares. In this sector, production of wheat ranks first, barely second, fodder third and cereals fourth. After these crops, garden products with a surface of 574 hectares under cultivation rank second. Here, grape production with a cultivation surface of 11000 hectares stands first.

Further, one of the development strategies of agricultural sector in the area under study is the water source management and planning for optimum productivity in order to increase the cultivation surface of water-farmed products. Husbandry ranks third in the agricultural sector in the region. Based on the data collected on the structure and sources of income of the residents of the region in all villages, cultivation and gardening serve as the first source of income and animal husbandry the second.

The production output and harvest per hectare is 2100kg for irrigated wheat, 800kg for dry-land wheat, 2600kg for irrigated barely, 900 kg for dry-land barely, and 7000kg for irrigated fodder plants.

The analysis of the above-mentioned performances shows the fact that the farmlands and irrigation water have not been put into proper and optimum use. Gardening enjoys a remarkable significance in the region, and in Jozan and Mozaran a bulk of farmlands have allocated their lands to vine gardens and most specifically to
vine gardens which occupy 4000 and 3500 hectares respectively. The analyses done indicate that the tonnage of vine gardens production is 18 tons per hectare on the average and the highest record has been 102 tons per hectare where most of this crop is dried into green raisin and is sold to the raisin factories which are later cleansed, sorted, packed and exported to other countries.

6.2.1. Importance of Estimating Crop Yield in Study Area

The ability to know the rate of production before harvest gives the possibility of planning sustainable agricultural development programs. The fact that the share of agricultural sector in the economy of Malayer is more than the share of industry and services, agricultural development and planning is very important. Among the agricultural crops, wheat has attracted a special attention among farmers. Wheat yield is important and wheat producing strategy seems necessary for achieving sustainable development in agriculture. Therefore, besides the land use planning and land monitoring of spatial planning a need is felt for quantitative land evaluation. Wheat in terms of production and cultivation is the most important strategic product of agriculture in Iran and in the study region. Thus, with regard to the importance of agricultural products and wheat on one hand and since, on the other hand, much of land in the area is devoted to dry wheat, it is inevitable to recognize to estimate wheat yield.

As it was already mentioned in chapter one, the main purpose of this study was “yield prediction wheat crop based upon Remote Sensing and GIS”, which includes three sub-goals as follows:

✓ To derive LAI from image satellite IRS LISS_ III data with the aim of using such data (NDVI & SAVI) to replace ground measurements.
✓ To investigate the correlation between gLAI and sLAI derived from satellite image
✓ To estimate the yield of dry land wheat in the middle of the growing season in Malayer region using a simple regression of yield model based on LAI.

6.3 Summary of the research study

In order to achieve the above-mentioned objectives, the measured images of IRS LISS_III dated in June, 11th, 2007 were processed after different corrections. With the use of survey field, the coordinates (x, y) of 250 points of phenomena in the region
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and different products existing in the region as well as 150 points of dry land wheat region, were taken by GPS. This sampling was done in a way that the sample spots were evenly dispersed. These spots were used in a supervised classification. By measuring the LAI directly and ground measuring of 150 points of dry land wheat land in the study area, regression analysis was obtained between the two variables and then the relationship between the two parameters was achieved using logarithm. Having coordinates of gLAI points in the environment of GIS, a point map was prepared. Using the software ILWIS, values of SAVI and NDVI were extracted from satellite images. Using Map Objects prepared by software ILWIS, corresponding points of each SAVI and NDVI were determined by gLAI. Then, by SPSS in a separate analysis, regression between gLAI and SAVI & NDVI, as well as the relationship between the indices were determined. The results of statistical calculations are indicative of high correlation between the SAVI & LAI rather than between NDVI & LAI. Therefore, extracting LAI from satellite images by using the SAVI seems appropriate than the NDVI. It shows that the SAVI compensates the weak points of NDVI in farming land with non-dense coating. Then, 20% of the samples (30 samples) were randomly chosen as a control group and validation. Calculating LAI through formula of model (Eq.5.4), the rate of dry land wheat was estimated. The matrix of Pearson correlation calculated between the amount of estimated product from the model and the other calculated amounts showed that there was a highly significant relationship between 120 samples and the other 30 samples. It indicates that the estimation of product by plant indices and satellite images has high use ability. To evaluate obtained model, mathematical formulas like RMSE, MSD, SDSD, and the like were used whose results of this analysis had been approved.

According to the results obtained from the classifications done in this research, MLC classification was proved to obtain the best result. In this classification, with regard to the training points given to the software, the region was divided into 18 classes and then by considering the accuracy assessment resulted from confusion matrix, which showed the productive accuracy of %95 and user production of % 88.7, Kappa coefficients was calculated to be %88.8. This amount is an indicative of the accuracy of classification of the region under study. Thus, the result of this classification can be used for a subject map for land use. The results of this research
indicate that LAI-based yield model can be used for estimating wheat crop in Malayer region.

The yield model that was validated by this research predicts yield \( y = \text{Mg ha}^{-1} \) as:

\[
Y = 0.691 \times \ln(\text{LAI}) + 1.312
\]

Another important point is that this empirical regression model was intended to estimate wheat dry-land yield in the area under study in the middle of the growing season since the peak growth period was so essential. In addition, in our analysis, the logarithmic expression showed a higher \( R^2 \) than the other expressions. Lastly, the SAVI selected for estimated LAI because it correlates well with canopy law density.

Results including the use of (Eq5.6) with 2006-2007 (n=120) and that of 2006-2007(n=30) validation data set showed there is a satisfactory match sLAI (from SAVI) and gLAI. The overall RMSE was reported to be 0.06 and 0.08 respectively. Further, there is a significant correlation between gLAI and SAVI according to Pearson matrix \( r = 0.975, P = 0.000 \). This high amount of correlation between these two variables can confirm this point that we can estimate the amount of LAI by making use of satellite images. Therefore, when sLAI was used instead of gLAI, mean simulation (absolute) error in terms of grain yield was increased to 0.01 Mgha\(^{-1}\). By considering this minimal increase in error, the replacement of gLAI by sLAI is regarded as feasible.

- Vegetation indices using R and NIR bands to estimate the LAI showed that NDVI drew weaker results than SAVI because of the soil background variation while SAVI worked quite well.
- As the methodology proposed for this study allows deriving early wheat yield prediction in a fast and economic way, it can be considered as a promising complement to the survey-based yield assessment, which are currently implemented by Agriculture organization in Malayer and most probably this method can be transferred to other regions with similar weather conditions as well.
As it was already mentioned in the previous chapter, high correlation was reported between the estimated yield from the model and the measured yield. Further, there was a high correlation between the calculated yield with sLAI model and the yield calculated by gLAI. Lastly, there was a correlation between the pilot sample (n=30) of the produced yield by means of gLAI and sLAI in the year 2006-2007. On the other hand, results of the initial validation of ground data showed that the yield model has an acceptable accuracy, which can be used in Malayer region. Further, grain yield was underestimated with an RMSE of 0.15 Mg ha$^{-1}$ (n=120), and that of 0.19 (n=30), in addition to MSD of 0.02 Mg ha$^{-1}$ (n=120) and that of 0.03 (n=30).

According to the analysis of data in the previous chapter, although NDVI has a better correlation with LAI, because the vegetation percentage is not 100% in the region under study, SAVI index is more suitable or appropriate for sLAI calculation.

### 6.4 Evaluation of the Hypotheses

According to the census of Agricultural Organization of Malayer, the region under study has 30000 hectares under the plantation of dry-land wheat. The average production of this yield has been reported to be 800 kg in hectare. Further, more than 90% of these lands are placed under the cultivation of dry-land wheat under the supervision of Agricultural Organization by establishing SANABEL plan. By taking this introduction into account, the hypotheses of this study are mentioned and evaluated as the following.

**H1. The LAI-based yield model can be used for estimating wheat dry land in the study area in Malayer in Western Iran and there is a significant relationship between LAI and yield.**

\[
Yield = f(LAI)
\]

This study based on Table 5.6 and Fig. 5.6 showed that there is a meaningful correlation at the level of is $P = 0.000$, $R^2 = 0.928$ between two variables of ground measure yield & gLAI (ground measure LAI) in 150 spots in dry land wheat in study area. The analyzed regression between the two variables showed the coefficient of 0.96 that was satisfactory. Using the logarithmic relationship obtained from the analysis of product estimate of gLAI in Eq.5.4, Pearson correlation was established between the measured yield and the estimated yield through gLAI. The result of the
matrix which is shown in Table (5.17) indicates that there is a correlation between these two variables at the level of $P = 0.000$. The correlation coefficient was also equal to 0.963 that these coefficients show that the hypothesis of the present study $H_1$ is confirmed.

$H_2$. For better sLAI estimation, the use of the other vegetation indices such as NDVI and SAVI needs to be explored. Therefore, there is a significant relationship between these indices (NDVI and SAVI) and sLAI.

$$\text{LAI} = f(\text{NDVI}, \text{SAVI})$$

The values of 150 spots of SAVI & NDVI indices were derived from satellite images during the farming year 2006-2007, which correspond with 150 gLAI their regression was analyzed separately by gLAI. The results of this regression are displayed in Tables 5.15 and charts 5.9 and 5.10 the findings show that there is a correlation between NDVI and gLAI at significant level $P=0.000$ and their correlation equals ($R^2$) 0.861, which means that as NDVI increases, LAI increases, too. The results from SAVI and LAI regression also showed that there is a logarithmic relationship between these two indices and these two are significant at the level $P = 0.000$, $R^2 = 0.962$ and their correlation coefficient is equal to 0.975. Therefore, according to the above points, there is a very high significant correlation between both indices of NDVI & SAVI and LAI and the hypothesis 2 is confirmed.

$H_3$. Since vegetation cover is not 100 percent in dry land wheat, there is more correlation between LAI and SAVI than LAI and NDVI.

As it was already mentioned in various parts of the dissertation, accuracy of calculations and carefully selected indices to be used in the crop yield model for estimating the yield are very important. As pointed out in the previous section, there is a meaningful relationship between the two indices and LAI, but as this study was done in the dry land area in Malayer region and vegetation cover in this region is not 100% and NDVI is sensitive to low vegetation cover and bare soil, so the correlation analysis between LAI and NDVI & SAVI which is displayed in Table 5.15 indicates that correlation coefficient between LAI & SAVI is more than the correlation coefficient between NDVI & LAI. Moreover, this can confirm that SAVI can make spectral variance due to changes in the field of soil reach a minimum value in such
pieces of lands. It is to be noted that Moreo et al. (2003), Buston and Fernandes (2004) and Baret and Guyot (1991) have also reached similar results. Thus, the hypothesis H3 is confirmed.

In addition, the matrix of correlation between two variables of gLAI & sLAI showed that these two are well-matched and the amount of calculated RMSE between the two parameters was 0.06 in that range was from GTOS and GCOS, while the calculated RMSE between two variables of NDVI and gLAI was 0.32 indicating that this issue is another reason for confirming replacement of SAVI in the equation (5.6) for calculating LAI. Thus, to extract LAI from satellite images, it is better to use SAVI in the equation (5.6) and by estimating the amount of sLAI the amount of yield can be predicted.

\textbf{H4. There is a significant correlation between gLAI and sLAI and the sLAI model can be used instead of gLAI.}

According to table 5.16, the correlation coefficient between sLAI \textsubscript{(SAVI)} and sLAI \textsubscript{(NDVI)} with gLAI were \( r = 0.981 \) and \( r = 0.912 \) respectively, which can be an indicative of this point that there is a significant relationship between sLAI \textsubscript{(SAVI)} and gLAI \( (P=0.000) \). Further, according to table 5.22, when sLAI was used instead of gLAI in (Eq.5.4) the rate of simulation error reached from 1.11 to 1.65% and from 1.02 to 1.38 %\( (n=120 \& n=30) \), respectively. It also shows that when sLAI was replaced gLAI was \( (n=120) \) the rate of simulation error did not change significantly (from 1.11 to 1.65 %) and there was about 0.36 difference at \( n=30 \) i.e., from 1.02 to 1.38%. In other words, mean simulation error increased about 0.36 at 30 samples and 0.55 at 120 samples.

\textbf{H5. There is correlation between ground measured yield (g\text{\textit{yield}}) and estimated crop using the crop yield model.}

The obtained results from table 5.17 indicate that there is a high significant correlation at \( P=0.000 \) level between s.yield \textsubscript{(SAVI)}, s.yield \textsubscript{(gLAI)} with g.Yield. Regarding these results, another important point which is worth mentioning here is that there is very little difference between the amount of correlation coefficient of s.yield \textsubscript{(SAVI)} and s.yield \textsubscript{(gLAI)}, which can be easily ignored. Therefore, based on the
available data in table 5.17, we can come to this conclusion that the estimated yield from sLAI (SAVI) has greater correlation in comparison to the estimated yield from sLAI (NDVI). In addition, results comprising the use of Eq. (5.5 & 5.6) with (2006-2007) data set (n=120) indicated a satisfactory match between sLAI (SAVI) and gLAI.

Another Pearson correlation was established among the variables after calculating the yield by establishing a regression model from sLAI (NDVI), sLAI (SAVI), and gLAI variables, and calculating it from regression model of Eq.(5.4) With regard to the obtained results, as it is has been indicated in table 5.13, we can conclude that there is a significant relationship between s.yield (SAVI) and s.yield (gLAI) index with the measured yield at the level of (P= 0.000, r = 0.962) and this index has more correlation coefficient than that of other variables with g.yield variable.

6.5 Conclusion

Regarding the results of this study, the following conclusions can be drawn:

- The results of this research indicate that LAI-based yield model can be used for estimating wheat crop in Malayer region. The yield model that was validated by this research crop yield model (Mgha⁻¹) as:
  \[ y = 0.691 \times \ln (sLAI) + 1.312 \]

- Another important point is that this empirical regression model was intended to estimate wheat dry-land yield in the area under study in the middle of the growing season since the peak growth period was so essential. In addition, in our analysis, the logarithmic expression showed a higher R² than the other expressions. Lastly, the SAVI selected for estimated LAI because it correlates well with canopy low density.

- As the methodology proposed for this study allows deriving early wheat yield prediction in a fast and economic way, it can be considered as a promising complement to the survey-based yield assessment, which is currently implemented by the Agriculture Organization in Malayer. Most probably this method can be transferred to other regions with similar weather conditions as well.

- Results including 2007(n=30) validation data set showed there is a satisfactory match sLAI (from SAVI) and gLAI. The overall RMSE was reported to be 0.06 and 0.08 respectively. Further, there is a significant correlation between gLAI and
SAVI according to Pearson matrix ($r = 0.975$, $P = 0.000$). This high amount of correlation between these two variables can confirm this point that we can estimate the amount of LAI by making use of satellite images. Therefore, when sLAI was used instead of gLAI, mean simulation (absolute) error in terms of grain yield was increased to the use of Eq. (5.6) with 2006-2007 ($n=120$) and that of 2006-0.01 Mg ha$^{-1}$. By considering this minimal increase in error, the replacement of gLAI by sLAI is regarded as feasible.

- Vegetation indices using R and NIR bands to estimate the LAI showed that NDVI drew weaker results than SAVI because of the soil background variation while SAVI worked quite well.

- A high correlation was reported between the estimated yield from the model and the measured yield. Further, there was a high correlation between the calculated yield with sLAI model and the yield calculated by gLAI. Lastly, there was a correlation between the pilot sample ($n=30$) of the produced yield by means of gLAI and sLAI in the year 2006-07. On the other hand, results of the initial validation of ground data showed that the yield model has an acceptable accuracy. It can be used in Malayer region. The results of the measurements and calculations showed that the estimation accuracy of product model is acceptable and can be used for estimating dry land wheat in the study area. The rate of RMSE model under estimation was equal to 0.15 Mg ha$^{-1}$ ($n=120$) and 0.19 Mg ha$^{-1}$ ($n=30$), which indicates good accuracy for farming year in the study area and indicates that the model with both variables of sLAI & gLAI are accurate enough to estimate products.

- To measure the overall deviation of the yield model, the MSD for the study area was calculated. The MSD value ($n=120$) was higher when the model used sLAI (0.02 vs. 0.03) and was the same for 30 samples.

- When using the two different types of LAI, input resulted in similar values for SDSD. The model can estimate wheat crop with a mean simulation error of less than 1% using gLAI or sLAI. This result shows that the LAI-based yield model can be used for estimating wheat dry-land in Malayer region.

- According to points mentioned above, although simulation error was increased due to sLAI was used instead of gLAI ($n = 30$ & $n = 120$) is 0.36 and 0.55 %, respectively, but this amount equals less than one percent. Moreover, it is evident
that there would not be errors when calculating in the farming planning in the region. On the whole, this replacement provided two important results for this research: First, This model can eliminate the laborious and exhausting operation and the cost of ground measurement of the products and can lead to ground measuring by LAI. Therefore, going through this process can save a lot of time and cost for measuring. Second, since this study is based on processing an image, it is specified that if a lot of time with a lot of precision is taken in ground measuring of the samples and image processing and extraction of parameters which are necessary in this research can be done carefully and completely. On the other hand, statistical and mathematical calculations should be done by using appropriate software which can be done by a satellite image having a good resolution at an appropriate time when the conditions are ideal for studying these processes in the region.

- According to the analysis of data in chapter V, although NDVI has a good correlation with LAI, because the vegetation percentage is not 100% in the region under study, SAVI index is more suitable or appropriate for sLAI calculation.
- This study has demonstrated, by using single data image, vegetation indices and ground measured data can be predicted up to 90%. Dadhwall and Ray (2000) explained yield variability when single data image based model for various crop including rice are used in some states of India. The timing of image to be used for yield estimation is important. Though Gielen et al. (2001) explained that there is a good correlation between NDVI and yield but using NDVI as end-of-season yield estimator gives unsatisfactory results because of the problems of choosing the best time of the image to use, Muthy et al. (1994) found that vegetation indices calculated from images taken at panicle initiation and heading stages have high correlation with yield. Therefore, they can best be used for yield prediction. This finding is almost similar to the finding of this study. In this case study a single date images, as demonstrated in this study, still provides good information to predict middle of season yield as long as it is within time when there is maximum vegetation between panicle initiation and heading stage. It should be noted that the plants ultimate growth is affected by its growth history and all the environment parameters. Therefore, remotely sensed data and other data are required to develop a functional relation between plant condition and yield. The use of data
acquired from space borne sensors will help to reduce the need for the laborious
ground based measurements and enhance the timeliness of information on crop
condition.

6.6 Suggestions
1. It is suggested that samples (i) should have steady dispersal in the region (ii)
should be representative of the classes of the introduced region (iii) should be
selected from four to eight places based on the importance of the class.
2. It is recommended that before field work with unsupervised classification, the
approximate number of the region should be determined. Then investigating the
peripheral data of the information classes corresponding with them should be
identified.
3. Time synchronization between field work and the time satellite passes: One of
the most important parameters in selecting satellite data when studying sources
is the data of collecting data. In arid land and semi-arid one, the suitable time
depends on the goal. For studies the same as the present study the best time is
when vegetation reflectance is high.
4. Precision in selecting resolution: Each remote sensing system is related to four
important resolution systems. Resolution is considered as criterion for an optical
system to distinguish indicators which are close to each other in terms of spatial
and similar in terms of spectral characteristics.
5. Using Real Time images in estimating is of paramount importance and exact.
Therefore, it seems necessary to consider Real Time in future research.
6. For predicting the other crops, planning should be made in a way that
coordinates x, y of all the products should be taken into account and their gLAI
should be measured and filed. Using this method or the other similar methods
can estimate the yields and this estimated amount can be used in planning for
farming.
7. It is highly recommended that if the climate of the area is suitable (not being
cloudy), more than one image for example two images with one month interval
should be repeated and the results should be calculated so that the yield estimate
can be done. In this manner, the research can be precisely carried out.
8. Topography can be used in investigating the relationship between producing dry land wheat and the location and height characteristics of the region in the future research.

9. Climatic factors should be used in investigating the relationship between producing dry land wheat and climatic features of the study area.

10. There are many vegetation indices that can be used in estimating wheat yield. Therefore, it is recommended that the other indices such as TSAVI should be used in the future research.

11. It is highly recommended that images like hyper spectral which have high resolution should be used in estimating yields.

6.6.1 Suggestions for Future Research

1. Since regression was used in this study, it is suggested that other statistical method like K-Nearest Neighbour Method can be used and compared with this method.

2. It is suggested that sat data such as NOAA, SPOT, Landsat, and MODIS should be used in estimating dry land wheat yield in the region and their results should be compared so that the best relationship can be reached between productions based on vegetation indices.

3. Plant diseases are one main factor for reducing and destroying yields. It is proposed that satellite images should be employed for identifying and detecting these diseases so that they can be helpful in estimating and diagnosing the diseases in the fields.

4. Plant pest such as wheat *Eurygaster integriceps put* is one of the factors of destroying yields of dry land wheat in the district. Every year it may cause problems for the farmers. It is advocated that the time and the area of the fields which are inflicted should be identified and the trace should be detected. In this manner, fighting against the dangerous pest can commence on time so that it can prevent more serious problems.

5. It is advocated that combination of GIS and crop growth simulation models should be implemented. The combination of these two enables a more effective analysis since the spatial and temporal dimensions are studied simultaneously resulting in a broader understanding about the implications of the indices under
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investigation. The analysis of crop level which uses crop growth model gives a clearer understanding of the interactions of the crops.

6. Since chlorophyll is considered as one of the most effective indicators of the intensity of the photosynthetic activities, ‘mechanistic model’ can simplify model development. Most of the mechanistic models are actually crop specific: CERES wheat for wheat.

7. The relationship between various environmental factors (climatic data and soil parameters) and crop yield will be the most common approach for estimating crop yields in the coming years.

8. The products from LAI data can be used to test the local validity of the available MODIS, LAI products (1 km resolution). If the MODIS LAI data give a reasonable estimate of LAI for the area for a comparable period of time, the data could be an alternative for continued monitoring the parameters in study area. Alternatively, the 250m reflectance data from MODIS can be used for local derivation of LAI based on empirical relationship. The advantage of this approach, if reliable, is that these data can be obtained daily or as eight-day composite products. It is highly recommended that the future research should be focused on plants like corn and wheat which have low LAI, a seasonal collection of biomass which has a correlation with product yield. Because there are about 10,000 hectares in which grapes are grown and the exporting market of grapes sometimes faces fluctuation, it is suggested that the amount of this product should be estimated by hyper spectral image.

9. Since reflections spectrum of dry land wheat and irrigated wheat is somehow similar, to prevent from likely mistakes in a large scale this product should be analyzed and its estimate should be calculated by data from the ground and satellite data. It seems necessary to investigate the relationship between wheat yield and land management parameters for dry land by satellite images.

10. It is highly required to investigate the relationship between amount of wheat yield and the characteristics of the soil of the district by satellite images. With respect to the water and soil erosion in dry land, investigating the land management and soil erosion by using satellite images is a must.

11. It is recommended that land with low efficiency and the factors causing products to decrease should be identified and some actions should be taken to defeat it.
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12. ‘Mechanistic model’ is one of the best methods. Mechanistic crop growth model stimulates the process of the carbon assimilation by using various environmental factors such as climatic information, management practice and soil characteristics. In the mechanistic crop growth models, various empirically and physically based relationships between physical environments and crop and soil conditions are integrated to simulate crop growth and estimate grain yield.

13. Computer-based image interpretation is one of the most intensively explored topics in recent studies of remote sensing. Although the best method for the analysis and interpretation of remotely sensed images is still regarded to be the eyes of trained technicians. The use of machine learning algorithms is currently regarded to be a key issue in the development of computer-based image interpretation techniques.

14. It is advised that Artificial Neural Network (ANNs) and Decision Trees (DTs) should be used in identifying wheat variety especially water wheat and barley in estimating yield. ANNs and DTs are being intensively explored as methods for classification and prediction in agriculture applications due to their flexibility and ability to incorporate a variety of types of ancillary information. The ANNs and DTs may provide effective alternatives in the development of yield mapping and forecasting system based on the remotely sensed information.

15. Precision agriculture is one of the main issues in modern agriculture in the world. It is advised that remote sensing data can be implemented in precision agriculture in the district.

16. Using the model FAO Crop Specific Water Balance (CSWB) which utilizes ground-based agro-meteorological data to estimate crop condition and when combined with crop production can estimate yield. The results of this method can be compared with the ones from regression to see which method is the best so that the best method can be used.