TÜBİTAK

TÜBİTAK-2209-A UNIVERSITY STUDENTS RESEARCH PROJECTS SUPPORT PROGRAM

The application form is expected to be prepared in Arial 9 font, taking into account the explanations given under each subject heading, and not to exceed a total of 20 pages excluding appendices (There is no lower limit). The evaluation will be made on the basis of the original value, method, management and widespread impact of the research proposal.

RESEARCH PROPOSAL FORM

Year 2024

1st Semester Application

2209/A RESEARCH PROPOSAL FORM FOR UNIVERSITY STUDENTS RESEARCH PROJECTS SUPPORT PROGRAM

A. GENERAL INFORMATION

Applicant's Name and Surname: Abass Issaka Mohammed
Co-Investigator: Sıla AYDIN, Fatih Alperen GILIÇ, Fatma Azra Savaş
Title of the Research Proposal: Weed Detection in Potato Field with Deep Learning Techniques
Name and Surname of the Advisor: Assoc . Prof. Dr. Zeynep ÜNAL
Institution/Organization where the research will be conducted: Niğde Ömer Halisdemir University, Faculty of Agriculture and Technologies

SUMMARY

The Turkish abstract is expected to include information about the research proposal's (a) original value, (b) methodology, (c) management, and (d) widespread impact. It is recommended that this section be written last.

Potato (*Solanum tuberosum*) is a type of herbaceous plant from the nightshade family whose tubers are eaten. Potatoes are considered a staple food source worldwide due to their high nutritional value, easy cultivation, productivity, long-term storage, and low cost. In addition to the potato plant, *resistant weeds such as Chenopodium album* L. and *Amaranthus retroflexus* L. occur that adversely affect crop health. In Turkey, especially in potato production, weed infestation, which leads to loss of yield, increases salinity in the soil due to water and nutrient consumption, causing barrenness. Traditional methods used in weed control require time and energy, as well as environmental pollution. When traditional methods are developed with the help of technology, it is possible to manage the process of combating foreign fishing rods more efficiently. In this project, it is aimed to apply deep learning techniques, which have been widely used in solving many complex problems in agricultural applications, especially in recent years, for weed detection problems. As the plant material to be used within the scope of the project, *Chenopodium album L, which is common in potato fields in Turkey.* and *Amaranthus retroflexus L*., as well as the Agria variety, which is widely produced in Niğde. In order to develop a model that can distinguish weeds from potato plants with high accuracy, both weeds and potato plants will be produced and RGB images of all classes will be obtained. After the developed model is trained and tested with these images, it will be made more robust using real field data. In addition to the fact that the images to be used in the training of the models are collected in a controlled environment, reliable and confirmed, the collection of real field data collected under different lighting conditions under the guidance of an expert consultant is an originality that distinguishes it from the models used in the literature. In addition, the fact that the study is carried out by students studying in three different disciplines and that advisors from each discipline contribute to the study will ensure that the problem is handled more healthily, while it will set an example for students to work in a multidisciplinary team. It is thought that this project, which is aimed to be developed, will ensure early and accurate detection of resistant weeds, improve crop health and increase crop yield with variable rate control techniques. Thus, a sustainable weed management will emerge that reduces environmental impacts while saving us both time and physical effort.

Keywords: Deep Learning, Weed Detection, Potato, *Chenopodium album, Amaranthus retroflexus*.

1. INTRINSIC VALUE

1.1. Importance of the Topic, Original Value of the Research Proposal, and Research Question/Hypothesis

The botanical characteristics of the potato plant are a type of herbaceous plant from the nightshade family (Solanaceae) whose tubers are eaten (Taşçı, 2016). Potatoes are considered a staple food source worldwide due to their high nutritional value, easy cultivation, productivity, long-term storage, and low cost. It has broad and rich green leaves, with thick and often smooth leaf margins. The potato produces small white to purple flowers with a characteristic star shape (Wang et al., 2020). Turkey is of great importance in terms of the agricultural sector, especially considering its ecology, climatic condition and soil structure in potato production; Potato cultivation is carried out in almost all provinces to a greater or lesser extent. According to 2019 production data, potato cultivation was carried out on an area of 141 thousand hectares in 71 provinces in Turkey and 4 million 980 thousand tons of potatoes were produced. 14.38% of the production was realized in Niğde province (TurkStat, 2020). It is highly ranked. With approximately 5.7 million tons of potato production in 2023, Turkey ranked 16th in world potato production and realized 1.4% of total world production (Nightingale, 2007). Among the prominent regions in potato production are provinces such as Niğde, Kayseri and Nevşehir, and Niğde province stands out with its production of 757,480 tons alone.

However, potato producers in Turkey face persistent problems such as weed infestation, which negatively affects the efficiency of agricultural activities. These weeds compete for nutrients, water, and sunlight from plants, resulting in poor crop growth, loss of production, and increased costs. In particular, **Chenopodium album L.** (commonly known as "Crowfoot") leaves are diamond-shaped, smooth or slightly wrinkled in texture. Its color is typically greener than that of the potato, with a steep height (Jabran et al., 2023). and **Amaranthus retroflexus L.** (commonly known as the "Red-Rooted Foxtail") leaves are oval and have flat edges. It has a dark green color and shows a reddish or purple color near the base of the plant (Alebrahim et al., 2012). The flowers are small and have an erect inflorescence (Tang et al., 2022). It is among the most problematic weed species in potato fields in Turkey and these species show resistance to herbicides. Traditional weed control methods, on the other hand, do not offer a sustainable solution because they are both labor-intensive and harmful to the environment (Mushinskiy et al., 2024). When traditional methods are developed with the help of technology, it is possible to manage the process of combating foreign fishing rods more efficiently. In this project, it is aimed to apply deep learning techniques, which have been widely used in solving many complex problems in agricultural applications, especially in recent years, for weed detection problems. The plant material to be used within the scope of the project, *Chenopodium album L.* and *Amaranthus retroflexus L*. Examples of studies available in the literature addressing the treatment of resistant weeds are given in Table 1.

Table 1. Research Studies on Weed Detection with Deep Learning Algorithms

Weed Name	Classification Method	Name of the Study	Reference/Source	Accuracy (Output)
Amaranthus macrocarpus, Urochoa panicoides, and Malva sp	**AI-based object detection model with Deep Neural Networks**	**"Deep neural networks to detect weeds from crops in agricultural environments in real-time "**	**Rakhmatulin et al., 2021**	**88.46%% (operational environment and unpublished dataset)**
Sugar beet weeds and many other weeds in different crops	**Image-based deep learning (CNN-based AI model)**	**“A survey of deep learning techniques for weed detection from images”**	**Hasan et al., (2021)**	**97% (Tested on a real dataset)**
Weed dataset including *Chenopodium*	**UAV imagery and machine**	**"Deep Learning Technique to classify**	**Bouguettaya et al., 2022**	**Accuracy between two studied fields,**

album L. & Amaranthus retroflexus L	**learning classification**	**Agricultural Crops Through UAV imagery"**		**of 78%, 79%, and 81.95%, respectively**
Potato plant and weed dataset	**AI-powered remote UAV with multispectral imaging**	**"Assessment of potato late blight from UAV based multispectral imagery "**	**Rodrigue et al., 2021**	**97.7% and 97.6% for dataset A and dataset B respectively**
Lolium perenne and Trifolium repens	**Machine learning with hyperspectral image analysis**	**"Identification of weeds based on hyperspectral imaging and machine learning "**	**Li et al., 2021**	**89.1%(lab environment)**
wheat spikes and spikelets	**Using DL models**	**Weed detection in wheat crops using image analysis and artificial intelligence (AI)**	**Haq ve ark., 2023**	**95.9 and 99.7%**

As a result of the literature searches, it was found that both these two different weed species (**Chenopodium album L.** and **Amaranthus retroflexus L.**) with the potato plant, and it has been observed that deep learning-based models that can classify with high accuracy using controlled environment data and real field data are limited.

Within the scope of the project, studies will be carried out, especially on the Agria potato variety. Agria potato is widely preferred in regions such as Niğde and Nevşehir with its resistance to diseases and high productivity (Kart et al., 2017). RGB camera images from various angles from potato fields will be used to create a dataset for weed detection. The obtained images will be analyzed with four different Convolutional Neural Network (ESA) architectures (VGG16, MobileNet, ResNet50, Inception) after passing through appropriate image processing stages and the best performing model will be selected. The selected ESA model will be trained on grown and collected data and optimized to adapt to the unique agricultural conditions of Niğde and Nevşehir. After the developed model is trained and tested with these images, it will be made more performant using real field data. The performance of the model will be evaluated by comparing it with the studies in the literature. In order to exhibit higher performance than in the existing studies in the literature, changes will be made in the model and a unique model will be obtained. In addition to the fact that the images to be used in the training of the models are collected in a controlled environment, reliable and confirmed, the collection of real field data collected under different lighting conditions under the guidance of an expert consultant is another originality that distinguishes it from the models used in the literature. In addition, the fact that the study is carried out by students studying in three different disciplines and that advisors from each discipline contribute to the study will ensure that the problem is handled more healthily, while it will set an example for students to work in a multidisciplinary team. It is thought that this project, which is aimed to be developed, will provide early and accurate detection of resistant weeds, improve crop health and increase crop yield with variable rate control techniques (Larkin et al., 2014). Thus, a sustainable weed management will emerge that reduces environmental impacts while saving us both time and physical effort. The fact that this model provides early and accurate weed identification for farmers will reduce production costs and improve environmental sustainability by reducing excessive use of herbicides and physical labor (Barbaś et al., 2023). In addition, if a successful deep learning model is developed, it is aimed to make this technology applicable in other agricultural areas.

1.2. Aims and Objectives

The purpose and objectives of the research proposal are written in a way that is clear, measurable, realistic and achievable during the research.

It is aimed to develop a Deep Learning-based model to detect weeds in potato fields. Chenopodium album L, *which is common in potato fields in Turkey*. and *Amaranthus retroflexus L*. It is planned to collect high-quality image data from a control environment such as a greenhouse using RGB cameras in order to distinguish resistant weeds such as L. from the Agria variety, which is widely produced in Niğde province. This dataset will include images of potato plants and two targeted weed species. Once the plants are in pots, they will be checked at regular intervals and watered as needed. In our project, 10 pots will be used for each of the weeds such as potato plant, *Amaranthus retroflexus* L. and *Chenopodium album* L. and for the potato plant. After the potato and weeds are ready for the image collection stage, the RGB camera will be used to collect images. The RGB camera is intended to be a usable low-cost solution for small-scale farmers, as it is suitable for distinguishing the colors and shapes of grasses and potatoes and is relatively inexpensive compared to other technologies. It is aimed to shoot 5 times in total, provided that it is 1 time a week. It is aimed to take each shot from 6 different angles (right, left, front, back and 2 different angles from the top) and thus the total number of images is 900 images. It is aimed to keep at least 600 images after image cleaning is applied to these images. The data collected from the controlled environment will be analyzed with four different Convolutional Neural Network (ESA) architectures (VGG16, MobileNet, ResNet50, Inception) after passing through appropriate image processing stages and the best performing model will be selected. Aggregated data and extended data will be used to determine the best performance among trained models. Magnification techniques such as flipping, rotating, and zooming will be used to expand the data and improve the performance of the model. After the developed model is trained and tested with these images, it will be tried to increase the performance by using real field data. At this stage, it is aimed to efficiently improve the performance in the field and correctly distinguish weeds from the crop depending on the different lighting conditions of the potato growth stages. Thus, a sustainable weed management will emerge that reduces environmental impacts while saving us both time and physical effort. It is among the goals of this model to provide early and accurate weed identification for farmers, to reduce production costs by reducing excessive use of herbicides and physical labor, and to indirectly increase environmental sustainability. In addition, if a successful deep learning model is developed, it is aimed to make this technology applicable in other agricultural areas.

2. METHOD

The methods and research techniques to be applied in the research proposal (including data collection tools and analysis methods) are explained with reference to the relevant literature. It is revealed that the methods and techniques are suitable for achieving the goals and objectives envisaged in the study.

The method section should cover the design of the research, dependent and independent variables, and statistical methods. If any preliminary studies or feasibility studies have been carried out in the research proposal, they are expected to be presented. The methods presented in the research proposal should be associated with the work packages.

This study will be carried out in the Agria variety of potato field, where it is widely produced in Niğde province. Agria potato is widely preferred in regions such as Niğde and Nevşehir with its resistance to diseases and high productivity (Kart et al., 2017).

Implementation Stages

This project was carried out in a controlled environment (greenhouse) at Niğde Ömer Halisdemir University Faculty of Agriculture and Technologies;

As potatoes *Chenopodium album L. and Amarantus retroflexus L*. To detect the species, it will take place in five stages. In Figure 1, the stages are given visually.

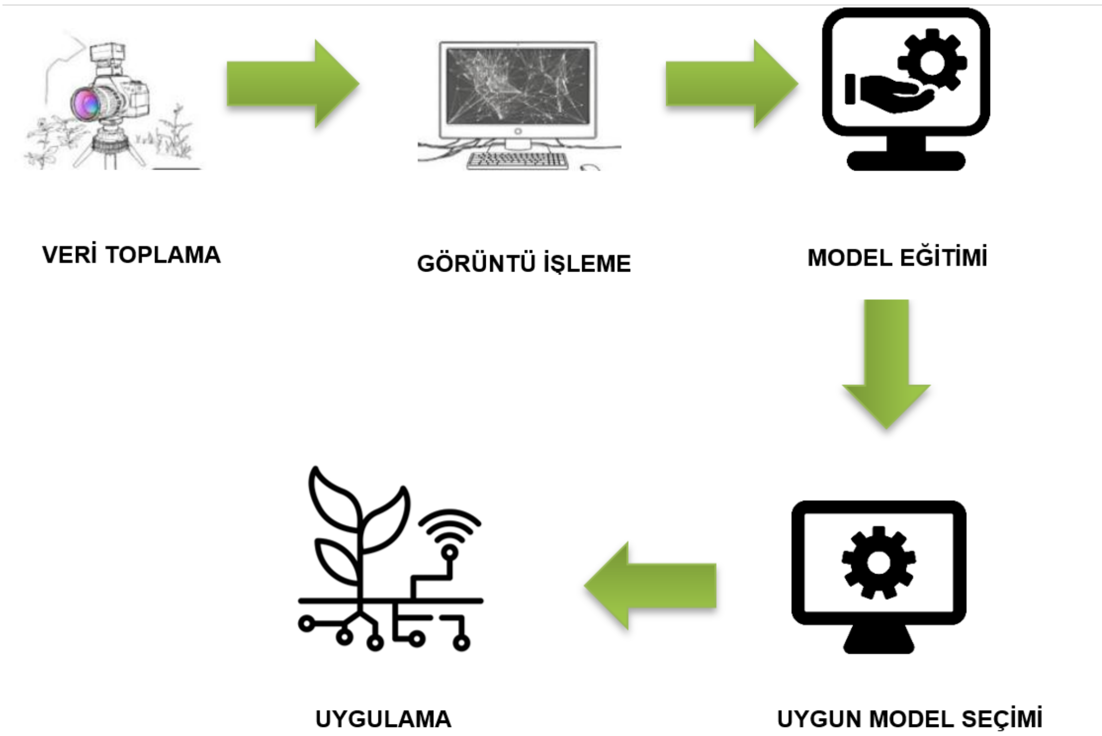


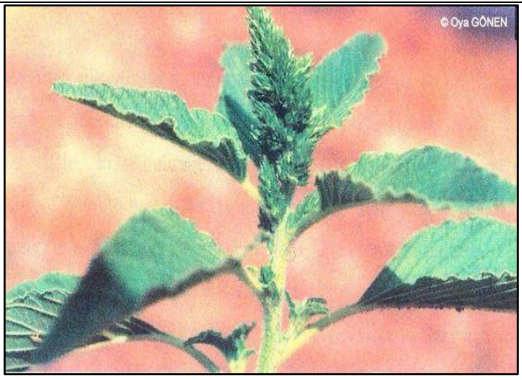
Figure 1. Project Phases

1. **Data Collection**

Using an RGB camera, images of potato plants and weeds (*Chenopodium album* L. and *Amaranthus retroflexus* L.) will be taken in different conditions and angles. Examples of the weed class to be used are given in Figure 2. Diversifying the images aims to better observe the effects of environmental factors and improve the accuracy of the model. These images will be collected together with the species of harmful weeds and images of potato plants and arranged in a data set folder. Once the dataset is generated, it will be divided into appropriate classes based on their content, and each image will be labeled with the correct class label.

After the plants are placed in pots, they will be checked at regular intervals and watered when needed. Planting potatoes and planting weeds will begin on a date set between April 1 and September 30. Potatoes are expected to emerge in 20-30 days, while weeds are expected to emerge in 7-15 days.

***Chenopodium album* L.**



***Amaranthus retroflexus* L.**

Figure 2. Examples of Weed

In our project, the potato plant*, Amaranthus retroflexus L*. and *Chenopodium album L.* 10 pots will be used for each of the weeds. A total of 5 shots will be made, provided that it is 1 time a week. Each shot will be carried out from 6 different angles (right, left, front, back and 2 different angles from the top). The total number of images will be 900 (Table 2). It is aimed to keep at least 600 images after image cleaning is applied to these images. If we have more than 600 images left, these remaining images will be included in the project and used.

Table 2. Data Set

SINIF	SAKSI SAYISI	GÖRÜNTÜ ÇEKİM AÇISI	GÖRÜNTÜ ÇEKİM SAYISI	GÖRÜNTÜLERİ ALMA SIKLIĞI	TOPLAM GÖRÜNTÜ SAYISI
Patates	10	6	5	HAFTADA 1 KEZ	300
Chenopodium album L.	10	6	5	HAFTADA 1 KEZ	300
Amaranthus retroflexus L.	10	6	5	HAFTADA 1 KEZ	300

Obtaining the right images will be a step that will directly affect the success of the model. For this reason, the technology used is of great importance. An RGB camera will be used to obtain a comprehensive image. RGB refers to a color model consisting of the initials of the words "Red, Green, Blue" (Gupta et al., 2014). In this color model, along with the basic colors, different colors are created by combining the basic colors with different densities. Each base color has a color intensity ranging from 0-255. At this intensity, 0 represents the color black, while 255 represents the color white. The saturation, brightness and opacity of the created colors also vary depending on the intensity of the combination. The RGB color model plays an important role in the display and transmission of colors in the digital environment (Neupane et al., 2019). The RGB camera is able to distinguish the chlorophyll content, developmental stages and morphological characteristics of each plant part. The RGB camera will be enough to distinguish the colors and shapes of grasses and potatoes. In addition, since RGB technology is more economical compared to other methods, RGB cameras are offered as an ideal option for farmers with small-scale land and for low-budget agricultural projects (Neupane et al., 2019). For these reasons, RGB image camera will be used in the project in order to take the images to be used in the created model in an appropriate way and to get the most efficient result. These photos will represent data that will train the model (Guo et al., 2017).

In this model, plants and weeds photographed in various ways with an RGB camera will be made ready for deep learning with image processing techniques.

2. Computer Vision

After data collection, various image processing steps will be applied to the images. These processes may include techniques such as noise reduction, sharpening, resizing, color corrections, filtering, and feature extraction (checking for bad or blurry images and removing detected faulty images from the dataset folder) to improve the analyzability of images. In this way, model performance will reach a better level and thus the risk of incorrect results will be minimized.

3. Model Training

The processed and classified images will be separated into three different data sets for the training, testing, and validation phases of the model. The training set will be used for the learning of the model; the test set will be used to evaluate the performance of the model; the validation set will be used to check the overall accuracy of the model, and the AI-based model will be trained with the selected deep learning architectures. After training with 4 different ESA models (VGG16, Mobile Net, ResNet50, Inception), the strengths and weaknesses of the models used will be discussed and compared.

One of the deep learning networks that are frequently used in R&D studies today is Convolutional Neural Networks (ESA). Convolutional Neural Networks (ESA), one of the sub-branches of deep learning, are generally used to analyze visual information. ESA, which is highly preferred today, will also be used in the model we will create (LeCun et al., 2015).

ESA is able to learn the properties on its own through filter optimization. These networks are feedforward networks. ESAs use less pre-processing than other image classification algorithms, which provides ease of use. For these positive reasons, we will use the ESA algorithm in our model (Dramé et al., 2016).

The classic ESA architecture, which is built using three main layers, consists of Convolution layers, Pool layers, and Fully Linked (FC) layers. The convolution and pooling layers are used for feature extraction, while the fully connected layers are used for classification (LeCun et al., 2015).

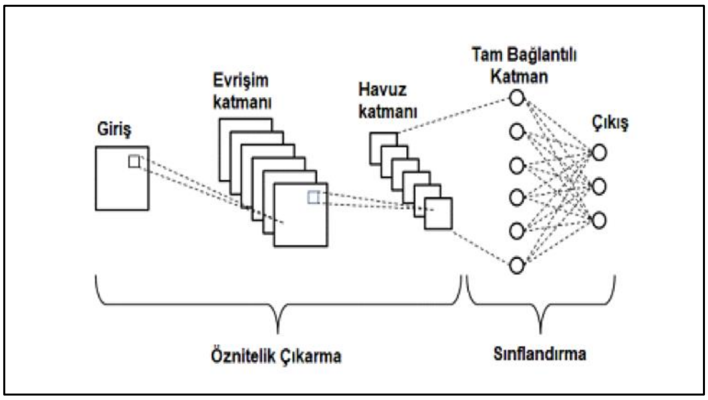


Figure 3. ESA Architecture Consisting of Three Main Layers (Ünal, 2023)

For this purpose, the most popular convolutional neural networks (ESA) such as VGG16, MobileNet, ResNet50, Inception will be tested respectively, and these 4 different deep learning architectures will be compared and the project will be continued with whichever of these architectures provides the highest accuracy and best performance for our model. In this way, a model will be developed that will detect weeds with appropriate resources without requiring any special conditions.

After the images are collected, Evolutionary Neural Networks (CNN) and deep learning techniques will be used. Image data will go through three phases: Pre-Processing, Training, Validation, and Testing phases (Ketkar et al., 2021).

- Pre-Processing: Raw data will go through stages of cleaning, transforming, scaling, rotating, or flipping to ensure model effectiveness. The background of the images, contrast enhancement, and light variations will also be taken into account.

- Training: It will be used to train the CNN dataset. The images will be divided into three clusters *(Solanum tuberosum, Chenopodium album L*. and *Amarantus retroflexus L*). 80% of the total dataset will be used for training and 20% for testing phases. The model will be trained to distinguish between weeds and potatoes based on their different characteristics.

- Test Phase: 20% of the dataset will be used here. Accuracy and error rate will be calculated to evaluate the effectiveness of the model. The model will go through common testing phases (unit, system, integration, and acceptance testing) for accurate learning.

4. Choosing the Appropriate Model

The ESA model with the highest accuracy rate for the project will be decided. The project will continue with the appropriate ESA model.

The most widely used success criterion, the mixed matrix given in Figure 4, will be used to evaluate model accuracy and performance of the model. Equations (1) and (2) will be used to calculate accuracy and error rate.

		Tahmin Edilen Sınıf	
		Pozitif Sınıf	Negatif Sınıf
Gerçek Sınıf	Pozitif Sınıf	a	b
	Negatif Sınıf	c	d

a: TP (True Pozitif)
DP (Doğru Pozitif)

c: FP (False Pozitif)
YN (Yanlış Negatif)

b: FN (False Negatif)
YP (Yanlış Pozitif)

d: TN (True Negatif)
DN (Doğru Negatif)

Figure 4. Confusion Matrix (Ünal et al., 2023)

- True positives (DP), weed labeled as true.

- False positives (YP), weed that has been incorrectly labeled.

-True negatives (DN) are correctly labeled potato plant.

-False negatives (YN) are incorrectly labeled potato plant.

$$Doğruluk\ Oranı = \frac{DP+DN}{DP+DN+YP+YN} \qquad (1)$$

$$Error\ Rate = \frac{YP+YN}{DP+DN+YP+YN} \qquad (2)$$

By calculating the accuracy and error rates thanks to the equations mentioned above, the progress and development of the model will be observed.

5. Application

The appropriate ESA model will be developed and divided into three different data sets for the training, testing and validation phases of the model. The training set will be used for the model to learn; test set, to evaluate the performance of the model; The validation set will be used to check the overall accuracy of the model and will be made ready for use in practical applications.

In this project, after the training and validation phase, the field testing phase plays a very important role. The model will be placed in potato plantations to make differentiation. At this stage, where different environmental factors such as climate, soil type, plant density and other factors will be tested, the sensitivity of the model will be revealed. The model will be tested in Niğde and Nevşehir potato fields. This will help in the remediation and evaluation phase. A total of 600 images will be obtained from the field and these images will be saved on a portable hard drive.

User inputs will be used to evaluate the model. The correlations in the dataset will give a clear idea of the model's accuracy over time and the learning rate. This will help improve and improve the model.

3 PROJECT MANAGEMENT

3.1 Work- Timeline

The main work packages and objectives to be included in the research proposal, the duration of each work package, the success criterion and the contribution to the success of the research are given by filling out the "Work-Time Schedule". Literature review, development and final report preparation stages, sharing of research results, article writing and material procurement should not be shown as a separate work package.
As a criterion of success, it is explained which criteria each work package will be considered successful when it meets. The success criterion is specified with quantitative or qualitative criteria (expression, number, percentage, etc.) in a way that is measurable and traceable.

WORK-TIMELINE (*)

IP No	Name and Objectives of Work Packages	By Whom(s) It Will Be Performed	Timeframe (.. -.. Moon)	Success Criterion and Its Contribution to the Success of the Project
1	Installation and operation of the hardware	Abass Issaka Mohammed	1-3	Equipment such as desktops will be installed in Niğde Ömer Halisdemir University Faculty of Agricultural Sciences and Technologies. Trials will be conducted to ensure that all tools work effectively. If these are taken and installed, they will be considered successful.
2	Supply of potato and weed seeds and greenhouse planting	Fatih Alperen Gilic Fatma Azra Savaş	1-3	It will be considered successful if all the plants needed are supplied and planted in the greenhouse for their development by planting ten different pots of each of the plants.
3	Data Collection: Obtaining potato and weed images	Abass Issaka Mohammed Fatih Alperen Gilic Fatma Azra Savas	1-6	An RGB camera will be used to collect images of plants.If 900 images or more are obtained, this work package will be considered successful.
4	Data preprocessing	Abass Issaka Mohammed Sila Aydin	6-8	Image data will go through various stages such as pre-processing and verification Here, the images will be considered successful if at least 900 healthy images are obtained and well classified.
5	ESA Model Development and Model Training	Abass Issaka Mohammed Sila Aydin	6-8	After the training is carried out with the selected 4 different ESA models VGG16, Mobile Net, ResNet50 and Inception, the potato weed detection rate of the models will be evaluated and the strengths and weaknesses of the models used will be compared and the model with the highest success rate will be selected.

6	Choosing the Appropriate Model			
7	Testing the selected model in a real environment	Abass Issaka Mohammed Fatih Alperen Gilic Sila Aydin Fatma Azra Savas	8-12	The model will be placed in the field for testing. This stage will be considered successful if the model achieves an 80% success rate in tests conducted under different environmental conditions and with data collected in the real environment.

(*) Rows and columns in the table can be expanded and duplicated as needed.

3.2 Risk Management

The risks that may adversely affect the success of the research and the measures to be taken to ensure the successful conduct of the research (Plan B) when these risks are encountered are outlined in the Risk Management Table below, specifying the relevant work packages. The implementation of plans B should not lead to deviation from the main objectives of the research.

RISK MANAGEMENT TABLE*

IP No	Top Risks	Risk Management (Plan B)
1	The problem with growing plants	Collecting data from the field
2	Problem with the Camera	Buying/using different cameras
3	Problems with data, such as insufficient data, errors, biases, and integration issues.	Data augmentation will be provided again by taking into account techniques such as rotational rotation, zoom and contrast.
4	Problem with the Model (Problems in the model, such as Low Accuracy, overfitting, and underfit, and biases.	Model optimization, adding new layers, model tuning

(*) The rows in the table can be expanded and multiplied as needed.

3.3. Research Opportunities

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TABLE OF RESEARCH OPPORTUNITIES (*)

Infrastructure/Equipment Type, Model in the Organization (Laboratory, Vehicle, Machinery-Equipment, etc.)	**Purpose of Use in the Project**
A plant cultivation facility will be established at Niğde Ömer Halisdemir University Faculty of Agricultural Sciences and Technologies,	Data collection will be obtained, which will be used for classification
Computer labs	Computer labs will be used to take photos with RGB cameras and develop artificial intelligence models.

(*) The rows in the table can be expanded and multiplied as needed.

4. WIDESPREAD IMPACT

If the proposed study is successfully carried out, the expected and expected common effects of the research, in other words, what outputs, results and effects will be obtained from the research are given in the table below.

TABLE OF COMMON EFFECTS EXPECTED FROM THE RESEARCH PROPOSAL

Common Types of Effects	Expected Output, Results and Effects of the Proposed Research
Scientific/Academic (Article, Paper, Book Chapter, Book)	Publications and Presentations, New Agricultural Artificial Intelligence Models, Educational Resources

Economic/Commercial/Social (Product, Prototype, Patent, Utility Model, Production Permit, Variety Registration, Spin-off/Start-up Company, Audio/Visual Archive, Inventory/Database/Documentation Production, Copyrighted Work, Media Coverage, Fair, Project Market, Workshop, Training, etc. Scientific Activity, Institution/Organization to Use Project Results, etc. other common effects)	Weed Detection System for Farmers, Research database, Sustainable Agriculture, In the long run, this will promote sustainable farming techniques, increase crop yields, and reduce pesticide use.
Researcher Training and Creating New Project(s) (Master's/Ph.D. Thesis, National/International New Project)	

5. BUDGET REQUEST CHART

Budget Type	Requested Budget Amount (TL)	Justification for Request
Consumables	2000	In the presented study, pots, nitrogen fertilizers, potato seeds, weeds and other materials to be used in growing potatoes.
Machinery/Equipment (Fixtures)	5000	The hard drive, flash memory and converter cable will be taken where the photos will be stored and transferred.
Service Procurement		
Transportation		
SUM	7000	

NOTE: If you have a budget request, both this table and the budget fields that will appear on the TÜBİTAK Management Information System (TYBS) application screen must be filled. If there is a difference between the figures in the budget items entered in the table above and the figures on the TYBS application screen, the data on the TYBS screen are taken into account and cannot be changed after the application.

6. OTHER MATTERS YOU WISH TO MENTION

Only information/data (graphics, tables, etc.) that can contribute to the evaluation of the research proposal can be added.

The fact that the study is carried out by students studying in three different disciplines and that advisors from each discipline contribute to the study will always ensure that the angle of the problem is handled more healthily, while it will set an example for students to work in multidisciplinary teams. Researchers involved in our project: Abass Issaka MOHAMMED and Fatma Azra AYDIN from the Department of Biosystems Engineering, Sıla AYDIN from the Department of Computer Engineering, Fatih Alperen GILIÇ from the Department of Agricultural Genetic Engineering. The Advisor of the Project is Assoc. Prof. Dr. Zeynep ÜNAL is Assoc. Prof. Dr. Khavar Jabran with her expertise in Weed, Assist. Prof. Hakan AKTAŞ will be supportive.

7. APPENDICES

APPENDIX-1: REFERENCES

- **Alebrahim, M., Majd, R., Rashed Mohassel, M., Wilcockson, S., Baghestani, M., Ghorbani, R., & Kudsk, P. (2012, December).** Evaluating The Efficacy Of Pre- And Post-emergence Herbicides For Controlling Amaranthus Retroflexus L. And Chenopodium Album L. In Potato. *Crop Protection*.

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