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Development and Evaluation of a Simulated Guide for Onion (*Allium cepa* L.) Production

Jerome Cabuloy[1], Cristopher Valencia[1], Dannielle Fenangad[1] and Nemesio Macabale[2]

[1]Graduate student, College of Engineering, Central Luzon State University
[2]Department of Information Technology, College of Engineering, Central Luzon State University

Email for correspondence: cabuloy.jerome@clsu2.edu.ph
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Abstract

In addition to environmental factors, the success of onion cultivation also depends on adopting sophisticated agricultural techniques and methods. Crop simulation models are now required to enhance onion cultivation, reduce risks, and increase yields. This study aimed to develop and evaluate a rudimentary C programming language-based onion production simulation software. This research created a simulation of a guide for producing onions. This simulation tool integrates agricultural expertise with technology to provide onion producers, researchers, and agricultural stakeholders with valuable insights and guidance. The simulation assists users in optimizing onion cultivation from planting to harvest through an in-depth look at best practices. The simulation incorporates essential facets of onion cultivation, such as planting techniques, irrigation strategies, insect and disease management, and market-driven decision-making. Advantages of the simulation include precise financial planning, resource allocation, and risk management. Users gain a greater comprehension of expected income, allowing them to budget more effectively and improve their market access strategies. In addition, the simulation encourages adopting sustainable agricultural practices, technological integration, and innovation in response to onion producers' evolving challenges.

Keywords: C program, crop simulation, farm modernization, onion production

Introduction

The agricultural industry has a prominent position in the economic landscape of the Philippines. According to Dogello and Cagasan (2021), the agricultural industry in the nation employs around 39.8 percent of the total labor force and makes a significant contribution of 20 percent to the Gross Domestic Product (GDP). Considering the substantial contribution of the agricultural sector to the nation's economy, researchers and farmers must collaborate to develop novel technologies and innovations that may effectively address the country's agricultural needs.

The onion has considerable value as a well-recognized condiment that is extensively used in our everyday routines. Furthermore, it stands as a highly lucrative horticulture crop cultivated on a global scale. The profitability of this investment is very appealing, as shown by a Return on Investment (ROI) of 197%. The domestic onion supply is insufficient to match the demand, as seen by the steady rise in the Philippine's imports of this product. Despite the profitability and potential market of onion production in the nation, there has been an upward trend in its output, with a little decline seen from 2017 to 2018. One contributing factor to this decline is farmers' insufficient training and awareness about onion cultivation and management (PSA, 2019).

The comprehensive procedure of onion production encompasses several stages, starting with the growing of seeds and concluding with the harvest of onion. This process involves meticulous management of storage, cleaning, processing, and packing activities. Nevertheless, it is worth noting that a significant number of onion farmers have shown proficiency and expertise in the production field. However, it is important to acknowledge that some techniques used by these farmers were not environmentally sustainable, as highlighted by Antalan et al. (2006). Understanding the appropriate techniques for onion cultivation is crucial for achieving a profitable and successful harvest characterized by enhanced productivity, robust development, and the cultivation of disease-free onions. The efficacy of onion cultivation is contingent not only upon environmental variables but also on assimilating sophisticated agricultural approaches and technology. Employing crop simulation models has become necessary to improve onion farming, limit risks, and boost yields.

A crop simulation model is a simulation model that characterizes the mechanisms of crop growth and development based on meteorological conditions, soil conditions, and crop management practices (USDA, 2022). According to Kephe, Ayisi, and Petja (2021), crop simulation models have the potential to serve as decision support systems for evaluating the potential risks and economic consequences associated with various agricultural management practices. Crop simulation models provide essential insights into the intricate dynamics of onion growth, development, and yield prediction. These tools facilitate the ability of farmers, researchers, and policymakers to make well-informed choices by enhancing their comprehension of the response of onions to different agronomic techniques, climatic circumstances, and scenarios related to climate change.

This work aimed to develop and assess a simple onion production simulation software using the C programming language. This program is a decision tool for farmers, technicians, and others interested in cultivating onions. Its aim is to provide comprehensive knowledge and skills necessary for successful onion farming, aiming to advance the sector in a highly competitive global context. The aforementioned simulation only considers the cultivation practices pertaining to onions and operates under the assumption of favorable environmental conditions.

Materials and Methods

Design of the Program

The program was developed based on relevant research and includes a comprehensive guide to equip farmers with the necessary information and skills for successful onion production. This is crucial since inadequate management of onion production may lead to significant financial, temporal, and labor-related setbacks. To produce a high yield, the cultivation of onions necessitates using many methods and agricultural practices. This approach aims to optimize resource utilization, minimize waste, and ultimately get a favorable return on investment. The design plan and program were developed with the CodeBlocks software tool. CodeBlocks is a versatile Integrated Development Environment (IDE) for the C++ programming language that facilitates the coding, debugging, building, running, and deployment of software projects across different operating systems (Gabeci, 2022). Figure 1 illustrates the procedural steps undertaken in the design and execution of the simulation.

The underlying principle of the application is to provide users with the ability to input various parameters, such as the desired planting area, costs associated with different field activities, and the prices of materials required for cultivation, including seeds, fertilizers, rents, and labor charges. Based on the provided data inputs, the application will thereafter develop a production guide outlining the day-to-day operations leading up to the harvesting day. Additionally, users have the ability to estimate potential earnings by inputting the prevailing farm gate pricing

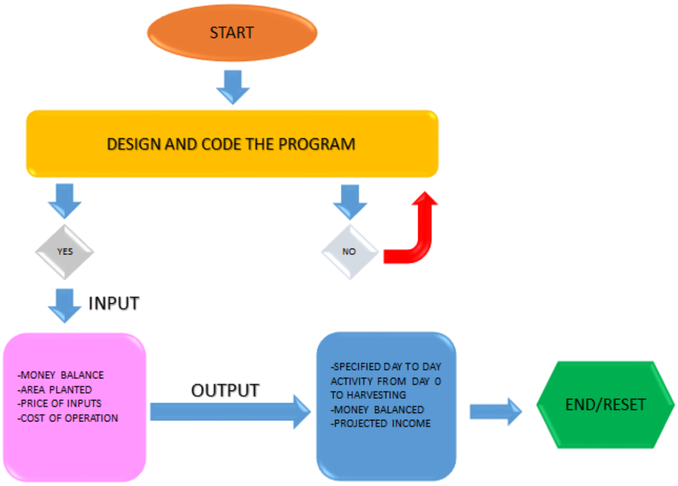
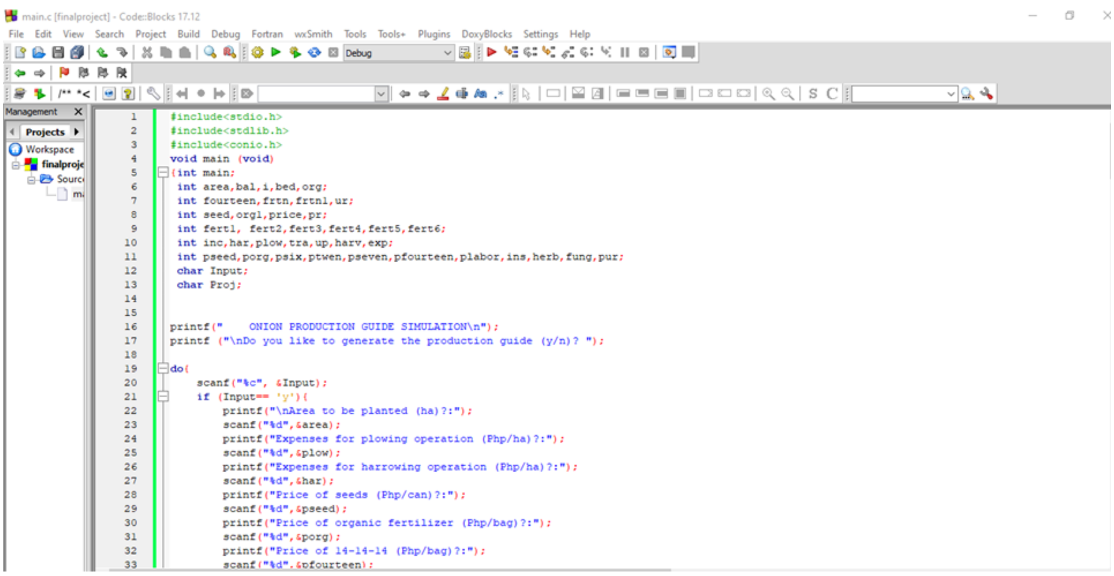


Figure 1. Onion production guide design and implementation

Results and Discussion

Principle of Operation

The coding used for the simulation is shown in Figure 2. The program will begin by asking questions about the input first and then generating a production guide. The planting area, the cost of agricultural supplies like seeds and fertilizer, labor for various tasks, and equipment rentals are all necessary inputs for the program. The remaining balance will be shown every day or week of production in the created production guide. The software will prompt inquiries on farm gate pricing and supplementary expenditures during harvest. Subsequently, the system will forecast the anticipated revenue, assuming the fulfillment of all favorable circumstances. The projected revenue may be assessed at various farm gate prices by entering "y" as the software is designed to loop.



```c
        printf("Price of 46-0-0 (Php/bag)?:");
        scanf("%d",&pur);
        printf("Price of 0-0-60 (Php/bag)?:");
        scanf("%d",&psix);
        printf("Price of 16-20-0 (Php/bag)?:");
        scanf("%d",&ptwen);
        printf("Price of 17-0-17 (Php/bag)?:");
        scanf("%d",&pseven);
        printf("Price of insecticide (Php)?:");
        scanf("%d",&ins);
        printf("Price of herbicide (Php)?:");
        scanf("%d",&herb);
        printf("Price of fungicide (Php)?:");
        scanf("%d",&fung);
        printf("Labor cost for seed sowing and rent for machinery and equipment (Php/day-ha)?:");
        scanf("%d",&plabor);
        printf("Labor cost for uprooting (Php/day-ha)?:");
        scanf("%d",&up);
        printf("Labor cost for transplanting (Php/day-ha)?:");
        scanf("%d",&tra);
        printf("Labor cost for harvesting (Php/day-ha)?:");
        scanf("%d",&tra);

        printf ("\n\n Press any integer to proceed:");
        scanf("%d",&pr);

        printf("\n\n        STATUS ");
            for (i=0;i<27;i++){
                printf("                                                  Day %d\n",i);
                bal= (area*150000);
                printf("Expected cost of Production: Php %d    \n", bal);
                printf("Area planted:                   %d hectares \n",area);
            for (i=0;i<27;i++){
            printf("\n================================================ Day 1 ============================================================\n",i);
            bal= (bal-(plow*area));
            printf("\n          to do: plow your land; do nothing up to day 6; proceed to harrowing on day 7\n",i);
                    printf("\nRemaining budget after the farm activity: Php %d ", bal);
        for (i=0;i<27;i++){
            printf("\n=============================================== Day 2-6 ===========================================================\n",i);
            bal=(bal);
            printf("\n          to do: do nothing up to day 6; harrow your land tomorrow\n",i);
                    printf("\nRemaining budget after the farm activity: Php %d ", bal);
         for (i=0;i<27;i++){
            printf("\n================================================ Day 7 ============================================================\n",i);
            bal=(bal-(har*area));
            printf("\n          to do: harrow your land; prepare your seedbed and do seed sowing tomorrow \n",i);
                    printf("\nRemaining budget after the farm activity: Php %d ", bal);
        for (i=0;i<27;i++){
            printf("\n================================================ Day 8 ============================================================\n",i);
            bed=(1000*area);
            org=(200*area);
            fourteen=(40*area),
            seed=(5*area);
            bal=(bal-(plabor*area)-(ins*area)-(seed*pseed/2.2)-(org*porg/50)-(fourteen*pfourteen/50));
            printf("\n          to do: prepare %d m^2 for you seedbed",bed);
            printf("\n                 seedbed size: 0.8-1 m wide, 20 cm high, length varies");
            printf("\n                 basal fertilizer: incorporate %d kg of organic manure", org);
            printf("\n                                   incorporate %d kg of 14-14-14", fourteen);
            printf("\n                 use %d kg of onion seeds for sowing", seed);
            printf("\n                 apply insecticide of either granular or liquid", org);
            printf("\n                 cover with rice straw and irrigate\n");
                    printf("\nRemaining budget after the farm activity: Php %d ", bal);
        for (i=0;i<27;i++){
            printf("\n=============================================== Day 9-14 ===========================================================\n",i);
            bal=(bal);
            printf("\n          to do: irrigate the seedbed using sprinkling can; do it every morning and late afternoon;");
            printf("\n                 skip when rain occurs; remove mulch on day 15\n");
                    printf("\nRemaining budget after the farm activity: Php %d ", bal);
        for (i=0;i<27;i++){
            printf("\n================================================ Day 15 ============================================================\n",i);
            bal=(bal-(fung*area));
            printf("\n          to do: remove mulch; continue watering up to day 22; remove weeds in  the seedbed;");
            printf("\n                 apply fungicide when dumping off is evident; apply at least once a week\n");
                     printf("\nRemaining budget after the farm activity: Php %d ", bal);
        for (i=0;i<27;i++){
            printf("\n=============================================== Day 16-26 ===========================================================\n",i);
            printf("\n          to do: continue watering the seedbed; apply fertilizer on day 27 \n");
        for (i=0;i<27;i++){
            printf("\n                 ========================= Simultaneous work on Day 24 =========================          \n",i);
            bal=(bal-(6*area*pfourteen));
            bal=(bal-(2*area*pur));
            frtn=(6*area);
            ur=(2*area);
            printf("\n          to do: continue watering the seedbed up to day 37;");
            printf("\n                 for the area allocated for transplanting; apply:");
            printf("\n                      %d bags of 14-14-14", frtn);
            printf("\n                      %d bags of 46-0-0\n", ur);
                    printf("\nRemaining budget after the farm activity: Php %d ", bal);
        for (i=0;i<27;i++){
            printf("\n================================================ Day 27 ============================================================\n",i);
            frtnl=(5*area);
            bal=(bal-(herb*area)-(frtnl*pfourteen/50));
            printf("\n          to do: apply %d kg of 14-14-14 and irrigate;", frtnl);
            printf("\n                 apply herbicide and pesticide only when necessary\n");
                    printf("\nRemaining budget after the farm activity: Php %d ", bal);
        for (i=0;i<27;i++){
            printf("\n=============================================== Day 28-37 ===========================================================\n",i);
            printf("\n          to do: continue watering the seedbed up to day 37; proceed hardening on day 38\n");
         for (i=0;i<27;i++){
            printf("\n                 ========================= Simultaneous work on Day 32 =========================          \n",i);
            orgl=(20*area);
            bal=(bal-(orgl*porg));
            printf("\n          to do: continue watering the seedbed up to day 37;");
            printf("\n                 for the area allocated for transplanting; apply:");
            printf("\n                      %d bags of organic fertilizer\n",orgl);
                    printf("\nRemaining budget after the farm activity: Php %d ", bal);
         for (i=0;i<27;i++){
            printf("\n                 ========================= Simultaneous work on Day 37 =========================          \n",i);
            printf("\n          to do: continue watering the seedbed up to day 37;");
            printf("\n                 for the area allocated for transplanting;");
            printf("\n                 start laying-out the field in preparation to transplanting\n");
                    printf("\nRemaining budget after the farm activity: Php %d ", bal);
        for (i=0;i<27;i++){
            printf("\n=============================================== Day 38-45 ===========================================================\n",i);
            printf("\n          to do: do not irrigate; observe up to day 45; irrigate on day 46\n");
                    printf("\nRemaining budget after the farm activity: Php %d ", bal);
         for (i=0;i<27;i++){
            printf("\n================================================ Day 46 ============================================================\n",i);
            printf("\n          to do: irrigate; seedling ready for uprooting\n",i);
                    printf("\nRemaining budget after the farm activity: Php %d ", bal);
         for (i=0;i<27;i++){
            printf("\n================================================ Day 47 ============================================================\n",i);
            bal=(bal-(up*area));
            printf("\n          to do: uproot the seedlings; irrigate the field where seedlings are to be transplanted \n",i);
                    printf("\nRemaining budget after the farm activity: Php %d ", bal);
         for (i=0;i<27;i++){
            printf("\n================================================ Day 48 ============================================================\n",i);
            bal=(bal-(tra*area));
            printf("\n          to do: transplant seedlings\n",i);
                     printf("\nRemaining budget after the farm activity: Php %d ", bal);
         for (i=0;i<27;i++){
            printf("\n=============================================== Day 49-60 ===========================================================\n",i);
```

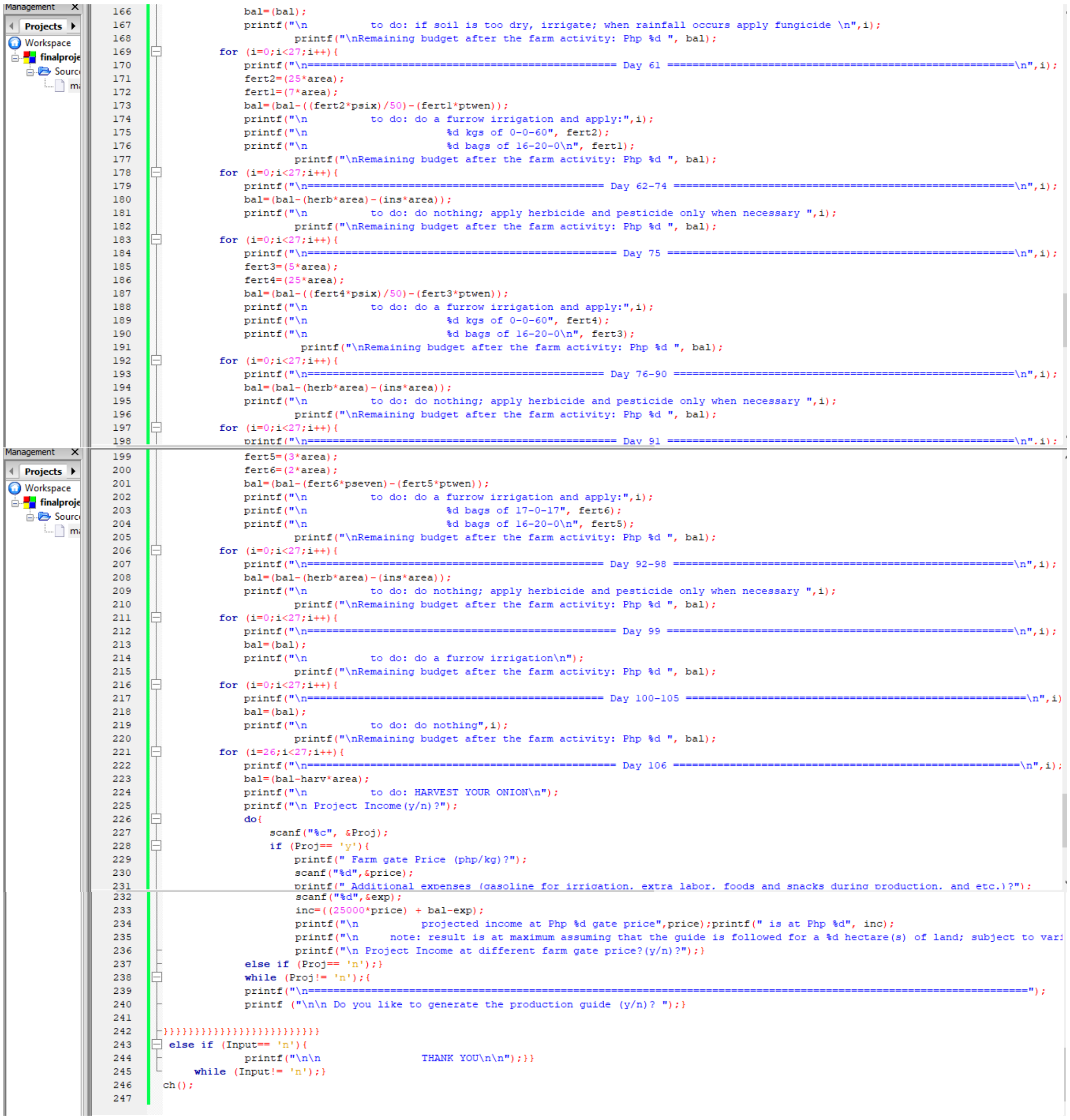


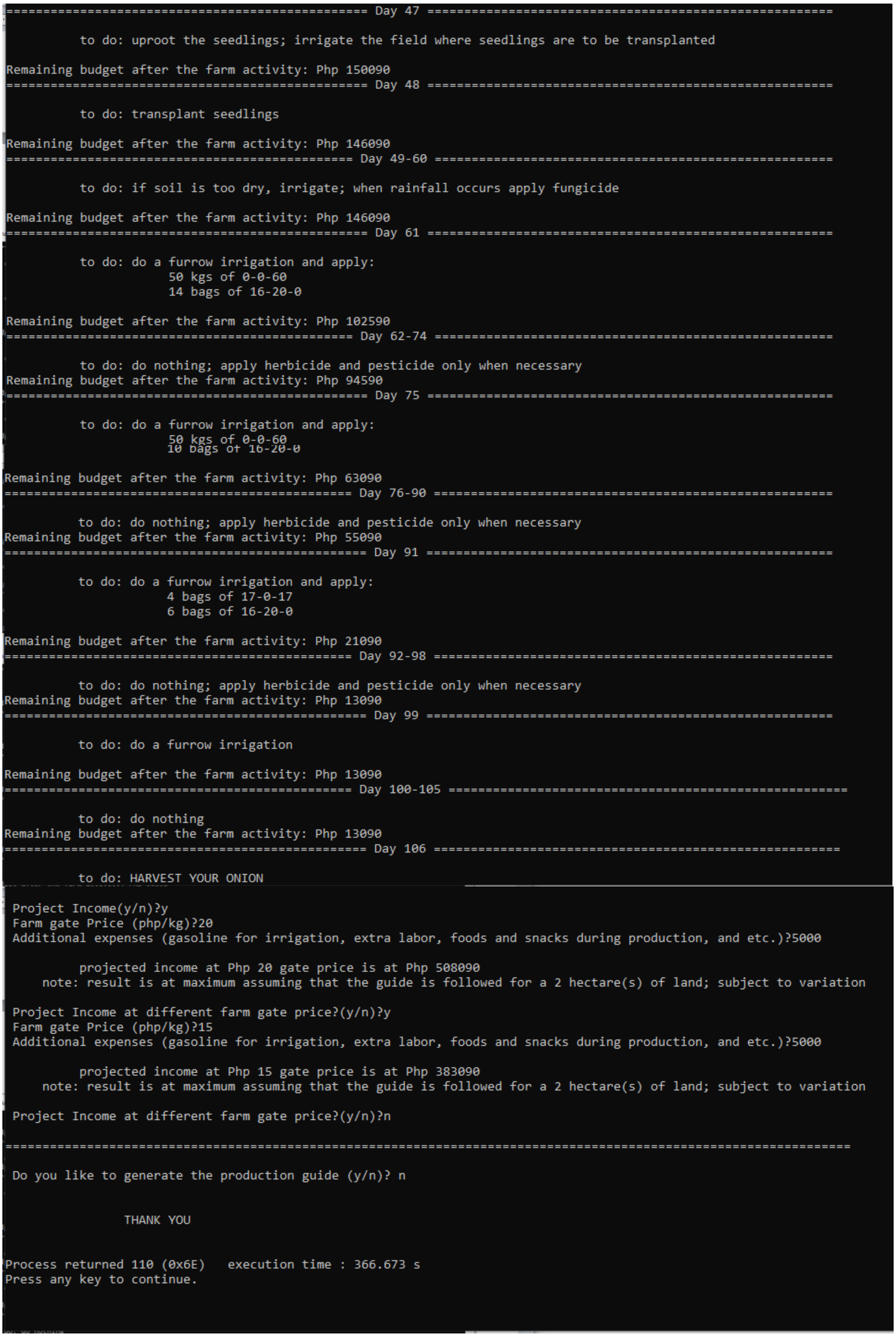
Figure 2. Onion production guide simulation program source code

Performance of the Program

Figure 3 shows a summary of the performance of the simulation. As evidenced by the results, the anticipated cost of production is provided at the beginning. Then, various farm activities were suggested, ranging from land preparation to harvesting, and the remaining balance was provided for each activity. In addition, projected revenue is provided following the suggested production activities. As shown in the figure, if the farm gate price is twenty pesos and additional expenses of five thousand pesos are incurred, the expected income will be 508,090 pesos. Alternatively, if the farm gate price is 15 pesos and the same additional expenses are incurred, the anticipated income will be 383,090 pesos

```
    ONION PRODUCTION GUIDE SIMULATION

Do you like to generate the production guide (y/n)? y

Area to be planted (ha)?:2
Expenses for plowing operation (Php/ha)?:2000
Expenses for harrowing operation (Php/ha)?:4000
Price of seeds (Php/can)?:3500
Price of organic fertilizer (Php/bag)?:1200
Price of 14-14-14 (Php/bag)?:3000
Price of 46-0-0 (Php/bag)?:1500
Price of 0-0-60 (Php/bag)?:1500
Price of 16-20-0 (Php/bag)?:3000
Price of 17-0-17 (Php/bag)?:4000
Price of insecticide (Php)?:2000
Price of herbicide (Php)?:2000
Price of fungicide (Php)?:1500
Labor cost for seed sowing and rent for machinery and equipment (Php/day-ha)?:1500
Labor cost for uprooting (Php/day-ha)?:1500
Labor cost for transplanting (Php/day-ha)?:1500
Labor cost for harvesting (Php/day-ha)?:2000


 Press any integer to proceed:1


        STATUS                                                    Day 0
Expected cost of Production: Php 300000
Area planted:                2 hectares
================================================ Day 1 =======================================================

          to do: plow your land; do nothing up to day 6; proceed to harrowing on day 7

Remaining budget after the farm activity: Php 296000
=============================================== Day 2-6 ======================================================

          to do: do nothing up to day 6; harrow your land tomorrow

Remaining budget after the farm activity: Php 296000
================================================ Day 7 =======================================================

          to do: harrow your land; prepare your seedbed and do seed sowing tomorrow

Remaining budget after the farm activity: Php 288000
================================================ Day 8 =======================================================

          to do: prepare 2000 m^2 for you seedbed
                 seedbed size: 0.8-1 m wide, 20 cm high, length varies
                 basal fertilizer: incorporate 400 kg of organic manure
                                   incorporate 80 kg of 14-14-14
                 use 10 kg of onion seeds for sowing
                 apply insecticide of either granular or liquid
                 cover with rice straw and irrigate

Remaining budget after the farm activity: Php 250690
================================================ Day 28-37 ===================================================

          to do: continue watering the seedbed up to day 37; proceed hardening on day 38

                ========================= Simultaneous work on Day 32 =========================

          to do: continue watering the seedbed up to day 37;
                 for the area allocated for transplanting; apply:
                      40 bags of organic fertilizer

Remaining budget after the farm activity: Php 153090
                ========================= Simultaneous work on Day 37 =========================

          to do: continue watering the seedbed up to day 37;
                 for the area allocated for transplanting;
                 start laying-out the field in preparation to transplanting

Remaining budget after the farm activity: Php 153090
================================================ Day 38-45 ===================================================

          to do: do not irrigate; observe up to day 45; irrigate on day 46

Remaining budget after the farm activity: Php 153090
================================================= Day 46 =====================================================

          to do: irrigate; seedling ready for uprooting

Remaining budget after the farm activity: Php 153090
```

DOI: https://doi.org/10.22137/ijst.2023.v7n1.06



```
================================================ Day 47 ======================================================

         to do: uproot the seedlings; irrigate the field where seedlings are to be transplanted

Remaining budget after the farm activity: Php 150090
================================================ Day 48 ======================================================

         to do: transplant seedlings

Remaining budget after the farm activity: Php 146090
============================================== Day 49-60 =====================================================

         to do: if soil is too dry, irrigate; when rainfall occurs apply fungicide

Remaining budget after the farm activity: Php 146090
================================================ Day 61 ======================================================

         to do: do a furrow irrigation and apply:
                     50 kgs of 0-0-60
                     14 bags of 16-20-0

Remaining budget after the farm activity: Php 102590
============================================== Day 62-74 =====================================================

         to do: do nothing; apply herbicide and pesticide only when necessary
Remaining budget after the farm activity: Php 94590
================================================ Day 75 ======================================================

         to do: do a furrow irrigation and apply:
                     50 kgs of 0-0-60
                     10 bags of 16-20-0

Remaining budget after the farm activity: Php 63090
============================================== Day 76-90 =====================================================

         to do: do nothing; apply herbicide and pesticide only when necessary
Remaining budget after the farm activity: Php 55090
================================================ Day 91 ======================================================

         to do: do a furrow irrigation and apply:
                     4 bags of 17-0-17
                     6 bags of 16-20-0

Remaining budget after the farm activity: Php 21090
============================================== Day 92-98 =====================================================

         to do: do nothing; apply herbicide and pesticide only when necessary
Remaining budget after the farm activity: Php 13090
================================================ Day 99 ======================================================

         to do: do a furrow irrigation

Remaining budget after the farm activity: Php 13090
============================================== Day 100-105 =====================================================

         to do: do nothing
Remaining budget after the farm activity: Php 13090
================================================ Day 106 ======================================================

         to do: HARVEST YOUR ONION

 Project Income(y/n)?y
 Farm gate Price (php/kg)?20
 Additional expenses (gasoline for irrigation, extra labor, foods and snacks during production, and etc.)?5000

          projected income at Php 20 gate price is at Php 508090
     note: result is at maximum assuming that the guide is followed for a 2 hectare(s) of land; subject to variation

 Project Income at different farm gate price?(y/n)?y
 Farm gate Price (php/kg)?15
 Additional expenses (gasoline for irrigation, extra labor, foods and snacks during production, and etc.)?5000

          projected income at Php 15 gate price is at Php 383090
     note: result is at maximum assuming that the guide is followed for a 2 hectare(s) of land; subject to variation

 Project Income at different farm gate price?(y/n)?n

================================================================================================================

 Do you like to generate the production guide (y/n)? n


                THANK YOU


Process returned 110 (0x6E)   execution time : 366.673 s
Press any key to continue.
```

Figure 3. Program output and execution

This program is extremely advantageous for producers, trainers, and stakeholders. With a proper onion production guide, onion yields are maximized. This ensures that producers obtain the optimum yield from their efforts, thereby increasing their profitability. Adhering to best practices reduces the likelihood of crop failure and pest/disease infestations. This increases the consistency and predictability of harvests, thereby decreasing the financial hazards associated with farming. Additionally, proper practices reduce resource waste. Utilizing resources such as seedlings, fertilizers, water, and labor more effectively reduces production costs and maximizes returns. Sustainable agricultural practices are frequently aligned with proper agricultural practices. This reduces environmental impacts such as soil erosion, water contamination, and greenhouse gas emissions.

Knowing the anticipated income from onion cultivation can be crucial for farmers and other agricultural stakeholders. The anticipated income projections give producers a clear picture of their prospective earnings from onion cultivation. This information is essential for financial planning, as it enables farmers to allocate resources prudently, budget for inputs, and make informed decisions regarding investments in their agricultural operations. In addition, farming is inherently hazardous due to weather, disease, and market fluctuations. Farmers can evaluate and manage these hazards more effectively, knowing their anticipated income. Farmers can implement risk mitigation strategies, such as crop insurance, diversification, and modifying planting schedules, if they clearly understand their potential earnings.

Despite the program's beneficial outcomes, there are also limitations. The program only considers favorable environmental conditions. Therefore, weather and environmental hazards are not considered. In addition, current modernized interventions in onion production were not accounted for in the generated production guide.

Conclusions

Through this research, a simulation of an onion production guide was developed. This inventive tool combines the power of technology and agricultural expertise to empower farmers, researchers, and agricultural stakeholders to pursue profitable and sustainable onion cultivation techniques.

The simulation provides users access to abundant information, allowing them to make informed decisions at every stage of onion cultivation. From precise planting and irrigation strategies to effective pest and disease management techniques, the simulation serves as a virtual mentor, advising users on best practices that maximize yield, quality, and resource efficiency.

In addition, the simulation provides a platform for risk assessment and management, enabling users to navigate the uncertainties of agriculture with greater confidence. Producers can engage in financial planning, resource allocation, and market access strategies that align with their objectives and market demands by understanding expected outcomes and income potential.

To optimize the application of this simulation, additional evaluation needs to be conducted. The simulation must be evaluated in various agricultural situations. In addition, environmental hazards should be considered to provide producers with an appropriate mitigation guide.

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We want to thank our professor in Basic Computer Programming, Dr. Nemesio Macabale, for patiently giving comments and suggestions to improve this study and program. We would also like to give back the credit to the Department of Science and Technology-Engineering Research and Development for Technology (DOST-ERDT) for the scholarship we enjoyed.

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