

PAPER • OPEN ACCESS

Preface

To cite this article: 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **672** 011001

View the [article online](#) for updates and enhancements.

You may also like

- [Advancing agricultural greenhouse gas quantification](#)

Lydia Olander, Eva Wollenberg,
Francesco Tubiello et al.

- [PREFACE](#)

- [1st International Conference on Food and Agriculture 2018](#)



245th ECS Meeting
San Francisco, CA
May 26–30, 2024

PRiME 2024
Honolulu, Hawaii
October 6–11, 2024

Bringing together industry, researchers, and government across 50 symposia in electrochemistry and solid state science and technology

Learn more about ECS Meetings at
<http://www.electrochem.org/upcoming-meetings>

 Save the Dates for future ECS Meetings!

EISSN: 1755-1315

IOP Conference Series

Earth and Environmental Science

The 3rd International Conference on Food and Agriculture (ICoFA)

“Development and Improvement of Sustainable Agricultural Practices Toward Environmental and Global Well-Beings”

XXX

VOLUME XXX – 2020

7 - 8 November 2020
Jember, Indonesia

EDITOR

Dr. Ir. Rosa Tri Hertamawati, M.Si. (Politeknik Negeri Jember, INDONESIA)

The open access journal for conference proceedings
conferenceseries.iop.org/ees

IOP Publishing



Content from this work may be used under the terms of the [Creative Commons Attribution 3.0 licence](https://creativecommons.org/licenses/by/3.0/). Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

The 3rd International Conference on Food and Agriculture (ICoFA)

Introduction of ICoFA 2020

We are honoured to present this collection of articles from the 3rd International Conference on Food and Agriculture (ICoFA), organized by Politeknik Negeri Jember (State Polytechnic of Jember). The conference was held in Jember, Indonesia, from 7 to 8 November 2020 and conducted virtually due to the pandemic of COVID-19. This annual event was intended to provide scientific forum and discussion of applied research on food and agriculture.

The theme of “Development and improvement of sustainable agricultural practices toward environmental and global well-beings”. There was 180 presenters and participants with 162 article submissions encompassing the topics of Agriculture Engineering and Biotechnology, Organic Agriculture, Agroindustry and Agribusiness, Animal Nutrition, Animal Production, Veterinary Science, Food Science and Technology, Food Safety, Food Security and Sovereignty, IT for Agriculture, and Renewable and Novel Energy Sources.

All submitted articles were reviewed and selected based on its scope as well as quality, and there are 105 articles that are selected for IOP Conference Series: Earth and Environmental Science. The list of committee members and reviewers are available in the pdf file.

List of Committee (ICoFA 2020)

List of Committe (ICoFA 2020)

Steering Committee

Associate Professor Toshinari Maeda (Kyushu Institute of Technology, JAPAN)
LH (Leon) de Jonge, Ph.D (Wageningen University and Research, NETHERLAND)
Dr. Lalita Siritattananon (Rajamangala University of Technology Thanyaburi, THAILAND)
Prof. Dr.Sc.Agr. Ir. Suyadi, MS., IPU., Asean Eng. (Brawijaya University, INDONESIA)
Prof. Dr. Indarto, S.TP., DEA (Universitas Jember, INDONESIA)
Dr. Ir. Dadik Pantaya, M.Si. IPU (Politeknik Negeri Jember, INDONESIA)
Dr. Ir. Rosa Tri Hertamawati, M.Si. (Politeknik Negeri Jember, INDONESIA)
Dr. Ir. Nurul Syamsiah, M.P. (Politeknik Negeri Jember, INDONESIA)
Syamsiar Kautsar, S.T., M.T. (Politeknik Negeri Jember, INDONESIA)

Organizing Committee (Politeknik Negeri Jember)

Saiful Anwar, S.TP, MP (Chairman of International Advisory Board)
Dr. Ir. Nanang Dwi Wahyono, MM (Chairman of Organizing Committee)
Prawidya Destarianto, S.Kom, MT (Secretary)
Mery Hadiyah Wati, S.Kom (Financial Treasury Support)
Dwi Putro Sarwo Setyohadi, S.Kom, M.Kom (IT Committee Coordinator)
Khafidurrohman Agustianto, S.Pd. M.Eng (IT Publication Coordinator)
I Gede Wiryawan, S.Kom, M.Kom (IT Publication)

Editor in Chief

Dr. Ir. Rosa Tri Hertamawati, M.Si. (Politeknik Negeri Jember, INDONESIA)

Editor

Associate Professor Toshinari Maeda (Kyushu Institute of Technology, JAPAN)
LH (Leon) de Jonge, Ph.D (Wageningen University and Research, NETHERLAND)
Dr. Lalita Siritattananon (Rajamangala University of Technology Thanyaburi, THAILAND)
Prof. Dr.Sc.Agr. Ir. Suyadi, MS., IPU., Asean Eng. (Brawijaya University, INDONESIA)
Prof. Dr. Indarto, S.TP., DEA (Universitas Jember, INDONESIA)
Dr. Ir. Dadik Pantaya, M.Si. IPU (Politeknik Negeri Jember, INDONESIA)
Dr. Ir. Rosa Tri Hertamawati, M.Si. (Politeknik Negeri Jember, INDONESIA)
Dr. Ir. Nurul Syamsiah, M.P. (Politeknik Negeri Jember, INDONESIA)
Dr. Ir. Ridwan Iskandar, MT (Politeknik Negeri Jember, INDONESIA)
Syamsiar Kautsar, S.T., M.T. (Politeknik Negeri Jember, INDONESIA)
Suluh Nusantoro, S.Pi, M.Sc. (Politeknik Negeri Jember, INDONESIA)
Retno Sari Mahanani, SP. MM. (Politeknik Negeri Jember, INDONESIA)

Peer Review Statement (ICoFA 2020)

Peer Review Statement (ICoFA 2020)

All papers published in this volume of IOP Conference Series: Earth and Environmental Science have been peer reviewed through processes administered by the Editors. Reviews were conducted by expert referees to the professional and scientific standards expected of a proceedings journal published by IOP Publishing.

- **Type of peer review: Single-blind / ~~Double-blind~~ / ~~Triple-blind~~ / Open / Other (please describe)**
- **Conference submission management system: online using easy chair**
- **Number of submissions received: 166**
- **Number of submissions sent for review: 140**
- **Number of submissions accepted: 115**
- **Acceptance Rate (Number of Submissions Accepted / Number of Submissions Received X 100): $115/166 \times 100 = 69.3$**
- **Average number of reviews per paper: 3**
- **Total number of reviewers involved: 7**
- **Any additional info on review process: -**
- **Contact person for queries: Dr. Rosa Tri Hertamawati**

Table of Contents (ICoFA 2020)

Table of Contents (ICoFA 2020)

PDF File Names	First Author Surname	Topic Heading	Article Title
001_ICOFA20	Asmono	Agriculture Engineering and Biotechnology	The effect of murashige and skoog (ms) modified medium and several types of auxins on the growth of stevia (<i>stevia rebaudiana bertonii</i>) in vitro
002_ICOFA20	Dewi	Agriculture Engineering and Biotechnology	Selection and evaluation of agronomic character of high temperature tolerant mutant gogo rice (<i>Oryza sativa</i> L) in nursery phase
003_ICOFA20	Kasutjaningati	Agriculture Engineering and Biotechnology	Growth and development of Vanda (<i>Vanda sanderiana</i>) explants in vitro on the effect of extracts of organic matter
004_ICOFA20	Budiati	Agriculture Engineering and Biotechnology	Efficacy of coffee peel extract as natural antimicrobial in coconut oil soap to against <i>staphylococcus aureus</i>
005_ICOFA20	Djamila	Agriculture Engineering and Biotechnology	Scale up and Performance Test of the Rotary Vacuum Dryer Type Batch for Drying Oyster Mushrooms
006_ICOFA20	Nasrudin	Agriculture Engineering and Biotechnology	Application of silica nutrients to improves local rice productivity under saline conditions
007_ICOFA20	Erawati	Agriculture Engineering and Biotechnology	Shoots multiplication of Vanilla (<i>Vanilla planifolia</i>) with benzyl amino purine and kinetin modification
008_ICOFA20	Nuraisyah	Agriculture Engineering and Biotechnology	Physical characterization of coconut fruit (<i>Cocos nucifera</i> L) in the region of Jember regency
009_ICOFA20	Siswadi	Agriculture Engineering and Biotechnology	Vernalization and Benzylamino Purine Treatments on The Generative Growth of Shallots (<i>Allium Cepa</i> Var. <i>Ascalonicum</i> L.) Bauji Variety in The Lowlands
010_ICOFA20	Apriani	Agriculture Engineering and Biotechnology	The effect of land use conversion on landslides risk in protected function areas: case study in samigaluh district, kulon progo regency, yogyakarta, indonesia

011_ICOFA20	Nurhidayah	Agriculture Engineering and Biotechnology	The effect of gamma radiation on the growth of black rice plants generation m1
012_ICOFA20	Rahmawati	Agriculture Engineering and Biotechnology	Yield and seed quality evaluation of several rice (<i>Oryza sativa</i> L.) lines with 'Ciherang' as a comparative variety
013_ICOFA20	Handayati	Agriculture Engineering and Biotechnology	Study on improvement of red chili pepper (<i>Capsicum annum</i> L.) cultivation technology
014_ICOFA20	Sugiyarto	Agriculture Engineering and Biotechnology	The effect of the use of various kinds of biochar and soil nutrients on pakcoy (<i>brassica rapa</i> l.)
015_ICOFA20	Wibowo	Agriculture Engineering and Biotechnology	Evaluation of kalibomo watershed water quality using the storet method
016_ICOFA20	Kurniawan	Agriculture Engineering and Biotechnology	Novel Adaptive Hysteresis Regime and Data Fusion on Crisp Logic in IoT-based Terrarium System for Improving Plant Growth Rate
017_ICOFA20	Iswahyono	Agriculture Engineering and Biotechnology	The design and build of ohmic heated hydro distillation for the essential oil extraction of eucalyptus leaves
018_ICOFA20	Poerwoko	Agriculture Engineering and Biotechnology	Genetic advance on tandem selection of several soybean genotypes
019_ICOFA20	Viandari	Agriculture Engineering and Biotechnology	Rice cultivation on dry land during dry season supported by deep well irrigation and soil amelioration
020_ICOFA20	Tyagita	Agriculture Engineering and Biotechnology	Strength and hardness of the engine mount prototype chopped fiber composite made from rubber compound and fiber ramie (<i>Boehmeria nivea</i>)
021_ICOFA20	Hermanuadi	Agroindustry and Agribusiness	Value added analysis of Cassava "Tape" Supply Chain in Bondowoso Regency
022_ICOFA20	Ambarkahi	Agroindustry and Agribusiness	Synchronization of Perception of Producers and Customers in an Effort to Improve the Quality of Services and Products of Puger Shrimp Paste
023_ICOFA20	Wahyono	Agroindustry and Agribusiness	Analysis up-stream agribusiness and counseling beef cattle development in jember
024_ICOFA20	Hidayanti	Agroindustry and Agribusiness	Added Value of Robusta Coffee Products of "Dwi Tunggal" Farmer Group in Bromo Mountain Slope
025_ICOFA20	Priyadi	Agroindustry and Agribusiness	Smallholder Farmers' Perceptions of Coffee Bean Processing Using The Honey Method

026_ICOFA20	Harlianingtyas	Agroindustry Agribusiness	and	Modeling of factors affecting the productivity of sugarcane in jember regency
027_ICOFA20	Susilowati	Agroindustry Agribusiness	and	Opportunities and challenges to increase corn export from Gorontalo Province of Indonesia
028_ICOFA20	Wiguna	Agroindustry Agribusiness	and	Marketing Strategy of Sumardi Farm's Goat Milk Business in Senduro District Lumajang Regency
029_ICOFA20	Widyatami	Agroindustry Agribusiness	and	Competitive and Comparative Advantages Analysis of Organic Rice Farming in Sumberjambe Sub-District Jember Regency
030_ICOFA20	Retnowati	Agroindustry Agribusiness	and	Policy Scenario of Sustainable Local Soybean Development in Banyuwangi Regency
031_ICOFA20	Muksin	Agroindustry Agribusiness	and	Analysis of the Sustainable Status of Post Disaster Crop Production in Sigi Regency, Central Sulawesi Province
032_ICOFA20	Yusuf	Agroindustry Agribusiness	and	Adlay (<i>Coix lacryma-jobi</i>), a potential source alternative to wheat flour: A financial feasibility analysis for small scale production
033_ICOFA20	Indriati	Agroindustry Agribusiness	and	Techno-economic analysis on cookies production made from Adlay (<i>Coix lacryma-jobi</i>) flour that supplemented with Moringa (<i>Moringa oleifera</i>) leaves powder
034_ICOFA20	Iskandar	Agroindustry Agribusiness	and	Determination of Leading Commodities and Food Commodities Structure in Sigi Regency of Central Sulawesi Province
035_ICOFA20	Pongoh	Agroindustry Agribusiness	and	Evaluation of Multidimensional Sustainability Status of Vannamei Shrimp Hatchery in Situbondo Regency
036_ICOFA20	Basriwijaya	Agroindustry Agribusiness	and	The Factors affecting Pitalah Duck farmer's income in Rokan Hulu district Riau province
037_ICOFA20	Malika	Agroindustry Agribusiness	and	Rapid Appraisal: A Sustainability Analysis of Dairy Cattle Agribusiness Based on Resources Accessibility
038_ICOFA20	Suryadi	Agroindustry Agribusiness	and	Study of the business sustainability of sheep as leading export commodity in Jember regency
039_ICOFA20	Imam	Animal Nutrition, Animal Production, and Veterinary Science		Effect of banana weevil enriched with β -glucan from <i>Saccharomyces cerevisiae</i> on productivity and abdominal fat of broiler chickens

040_ICOFA20	Rahmasari	Animal Nutrition, Animal Production, and Veterinary Science	Addition of papaya (<i>Carica papaya</i> L.) seed meal on quail production performance
041_ICOFA20	Pantaya	Animal Nutrition, Animal Production, and Veterinary Science	The hematological profile and immune response treated by heat stress on "Gaok" native chickens
042_ICOFA20	Prasetyo	Animal Nutrition, Animal Production, and Veterinary Science	The sensory characteristics of fortified beef sausage with duck eggshell nano-calcium
043_ICOFA20	Hertamawati	Animal Nutrition, Animal Production, and Veterinary Science	Actions of edamame soybean isoflavones in an avian model: the Japanese quail (<i>Cortunix-cortunix japonica</i>)
044_ICOFA20	Awaludin	Animal Nutrition, Animal Production, and Veterinary Science	Herbal anthelmintic: the effectiveness of worm infections control in sheep using urea molasses block containing tobacco (<i>nicotiana tabacum</i>) waste
045_ICOFA20	Kusuma	Animal Nutrition, Animal Production, and Veterinary Science	Identification of Helminth Parasites Diversity on Layer Chicken in Jember District (East Java – Indonesia)
046_ICOFA20	Budiati	Food Safety	Antimicrobial activity of jengkol and petai peel extract to inhibit <i>Listeria monocytogenes</i>
047_ICOFA20	Destarianto	Food Safety	Development of integrated swab chamber for drive thru Covid19 test system
048_ICOFA20	Rindiani	Food Science and Technology	Steamed cake with okra flour substitution as an alternative to snack for a fiber source
049_ICOFA20	Purwaningsih	Food Science and Technology	The effect of temperature variations on koro sword bean flour (<i>canavalia ensiformis</i> l) and the concentration of the addition of koro sword bean flour on cyanide acid (hcn) content and consumer acceptance of fried chicken seasoning flour
050_ICOFA20	Handayani	Food Science and Technology	Characteristics bioactive compound of <i>muntingia calabura</i> kersen leaves in grow up height different (distic area)
051_ICOFA20	Kristanti	Food Science and Technology	The color and texture properties of mushroom chicken nugget with various flour as a filler
052_ICOFA20	Ratri	Food Science and Technology	Effects of time and temperature variations on curcumin contents and antioxidant activity of tamarind-turmeric herbs

053_ICOFA20	Fibrianto	Food Science and Technology	Just about Right Analysis of coffee leaves tea bitterness and astringency by modifying brewing temperature and time
054_ICOFA20	Subaktilah	Food Science and Technology	Chemical Characteristic of Steamed Pumpkin Brownies Premix Flour
055_ICOFA20	Rosiana	Food Science and Technology	Polyphenol content and antioxidant activity of beverage from dragon fruit peel powder and soy powder
056_ICOFA20	Hidayat	Food Science and Technology	Polyphenol content and antioxidant activity of beverage from dragon fruit peel powder and soy powder
057_ICOFA20	Surahman	Food Science and Technology	Formulation and Production Costs Optimization of Complementary Food for Breast Milk from Red Sorghum Flour (<i>Sorghum bicolor</i> L.), Red Bean Flour (<i>Phaseolus vulgaris</i> L.) and Mungbean Flour (<i>Phaseolus radiatus</i> L.) Using Linear Programming Method
058_ICOFA20	Rahman	Food Science and Technology	The effect of temperature and time of baking to sensory quality of banana-based food bars
059_ICOFA20	Sismina	Food Science and Technology	Effects of active packaging for maintaining quality of "wingko" traditional food in a tropical environment
060_ICOFA20	Herminiati	Food Science and Technology	The estimation of shelf life of instant porridge in the different packaging with method of accelerated shelf life testing of arrhenius model
061_ICOFA20	Ningsih	Food Science and Technology	Sensory characteristics of mille crepes cake from seaweed powder
062_ICOFA20	Ananda	Food Science and Technology	Substitution of fishbone powder in the development of choco chips cookies
063_ICOFA20	Hartati	Food Science and Technology	Physical, chemical and organoleptic quality of sweet potato leaves (<i>Ipomoea batatas</i> L.) ice cream
064_ICOFA20	Nisa	Food Science and Technology	Quality characterization of "wingko" traditional food by applying vacuum packaging in a tropical environment
065_ICOFA20	Santi	Food Science and Technology	Moringa chicken nugget as supplementary food for toddler to prevent stunting
066_ICOFA20	Yudiastuti	Food Science and Technology	The Effect of Ozonation Time and Contact Time of Edamame Washing on Color Changes Using the Continuous Type Ozone Washing Method

067_ICOFA20	Apriliyanti	Food Science and Technology	Antioxidant Activity and Sensory Properties in Packaged Beverages with Melinjo Peel, Mint Leaves, and Stevia Leaves Formulations
068_ICOFA20	Sukasih	Food Science and Technology	The improvement of white pepper quality using ozone application
069_ICOFA20	Kurniawati	Food Science and Technology	The effect of sodium metabisulfite concentration and drying time on the quality of coconut sugar
070_ICOFA20	Suratno	Food Science and Technology	Optimization of making white oyster mushroom with the effect of immersion time and concentration of natrium metabisulphite
071_ICOFA20	Mayasti	Food Science and Technology	Selection of Plantain Cultivars as Raw Material for Ripe Plantain Flour
072_ICOFA20	Yulianti	Food Science and Technology	Physicochemical and gelatinization properties of ethanol-treated sorghum flour
073_ICOFA20	Ardiah	Food Science and Technology	The effect of of cassava variety and fermentation duration on the texture and acceptabiity of cooked-dried growol
074_ICOFA20	Ratri	Food Science and Technology	The Effect of chocolate Drink To Hepatosomatic Index of Diabetes Mellitus Induced Rat
075_ICOFA20	Fitriyah	Food Science and Technology	Functional Analysis of The Bioactive Compound Contents and Antioxidant Activity of Extract Red Rice Beverage
076_ICOFA20	Wibisono	Food Science and Technology	Characterization β -glycosidase of Tempeh from Rejected Edamame Soybean and Determination Method of Extracted Genistein by Conventional and Compared Using of Modern Method
077_ICOFA20	Muzaifa	Food Science and Technology	Utilization of Coffee By-Products as Profitable Foods - A Mini Review
078_ICOFA20	Diono	Food Science and Technology	Extraction and Micronization of β -glucan in One-step Process by Combining Subcritical Water and Supercritical Carbon Dioxide
079_ICOFA20	Iqbal	Food Science and Technology	Analysis of integration dietducate and automated meal planner for nutritional purposes
080_ICOFA20	Damanhuri	Food Security and Sovereignty	Nitrogen and Biodegradator Application to Trigger Ratoon Growth and Production of Rice (<i>Oryza Sativa</i>)
081_ICOFA20	Purwadi	IT for Agriculture	Radio Waves-Based Landslide Mitigation System

082_ICOFA20	Utomo	IT for Agriculture	patial analysis and mapping of landslide prone areas in kemuning lor village, sub-district arjasa, district of jember
083_ICOFA20	Wibowo	IT for Agriculture	The Development of Visualization of The Small and Medium Industry Distribution (IKM) Using A Web-Based Geographic Information System
084_ICOFA20	Riskiawan	IT for Agriculture	On-line monitoring system in greenhouse area for chrysanthemum cultivation based on Raspberry Pi and IoT
085_ICOFA20	Fitri	IT for Agriculture	Application of Backpropagation Method for Quality Sorting Classification System on White Dragon Fruit (<i>Hylocereus undatus</i>)
086_ICOFA20	Lesmana	IT for Agriculture	Visual cueing modulation of cycling speed for training person with stroke in a virtual cycling system
087_ICOFA20	Purnomo	IT for Agriculture	Liquid load optimization of unmanned aerial vehicle for foliar fertilizer
088_ICOFA20	Agustianto	IT for Agriculture	Development of Realtime Surface Modeling Vehicle for Shrimp Ponds (ReSMeV-SP)
089_ICOFA20	Hariono	IT for Agriculture	Development of personal integrated sterilization machine for new normal phase preparation of the 2019-ncov outbreak
090_ICOFA20	Agustianto	IT for Agriculture	Development of automatic temperature and humidity control system in kumbung (oyster mushroom) using fuzzy logic controller
091_ICOFA20	Suastika	Organic Agriculture	The agronomy performance and resistance to brown planthopper on superior rice varieties in Bali Province, Indonesia
092_ICOFA20	Sugiyarto	Organic Agriculture	Exploration of agricultural waste as biochar to increase soil fertility of Udipsammets in Jember District
093_ICOFA20	Riyanto	Organic Agriculture	The Effect of Biological Fertilizer Application on Soil Fertility, Heavy Metals Reduction and Eggplant Yield on the rice field of Bantul Regency
094_ICOFA20	Kasutjjaningati	Organic Agriculture	The production of pak coy (<i>Brassica rapa L</i>) based on cleaner coffee production
095_ICOFA20	Saliem	Organic Agriculture	Supporting organic rice exports: the success story of West Java organic rice exports

096_ICOFA20	Erdiansyah	Organic Agriculture	Utilization of javanese ginseng and citronella for insect diversity in pace village, Jember regency
097_ICOFA20	Erdiansyah	Organic Agriculture	Virulence of Spodoptera Litura Nuclear Polyhedrosis Virus (SLNPV) with kaolin as carrier material on spodoptera litura and tetragonula laeviceps on soybean
098_ICOFA20	Kusparwanti	Organic Agriculture	Dose treatment of legume compost with the number of plants per planting hole for land efficiency and increasing sweet corn production
099_ICOFA20	Firmansyah	Organic Agriculture	Toxicity of Sphagneticola trilobata extracts against Spodoptera litura larva
100_ICOFA20	Guntara	Organic Agriculture	Growth and yield of pagoda (Brassica narinosa L) with concentration and watering interval of fermented rabbit urine on hydroponic system
101_ICOFA20	Sukri	Organic Agriculture	The increasing fertility of sandy soil and chili production through the application of organic fertilizers, zeolite and cane blotong
102_ICOFA20	Udin	Renewable and Novel Energy Sources	Emission Characteristics and Fuel Consumption of Biodiesel Obtained from Fish Canning Industry Waste in Agriculture Diesel Engine
103_ICOFA20	Rachmanita	Renewable and Novel Energy Sources	Experimental investigations on the performance of thermoelectric generator as energy conversion system
104_ICOFA20	Biyanto	Renewable and Novel Energy Sources	Stuck Pipe Optimization Using Duellist Algorithm
105_ICOFA20	Biyanto	Renewable and Novel Energy Sources	Optimization of energy efficiency in natural gas liquefaction process using plantwide control method

Liquid load optimization of unmanned aerial vehicle for foliar fertilizer

F E Purnomo¹, F L Afriansyah²

¹Department of Engineering, Politeknik Negeri Jember, Mastrip Road PO BOX 164 Jember, Indonesia

²Department of Information Technology, Politeknik Negeri Jember, Mastrip Road PO BOX 164 Jember, Indonesia

*Email: fendik_eko@polije.ac.id

Abstract. Unmanned Aerial Vehicle is a multicopter vehicle with more than one rotor to produce lift for the vehicle to fly in the air. Multicopter has become the object of research, one of which is in agriculture. Fertilization is more concerned about liquid fertilization, which is directly spraying on the leaves or foliar fertilizer. Foliar fertilizer sprayed with the hope that the stomata on the leaves can directly absorb the nutrients given. The UAV will fly carrying liquid (liquid) foliar fertilizer and spraying it on a predetermined land using a flight path that has been programming in the UAV. In previous research, we have used a multicopter type UAV combined with a foliar spraying system with a 1-liter liquid fertilizer, which can only spray land with a limited area. The limited liquid capacity will be a problem for the UAV because it is necessary to fill the liquid many times if used to spraying a wider area. Therefore, it is necessary to optimize the liquid load on the UAV so that its capacity will increase. If UAV's liquid foliar fertilizer's capacity increases, it will increase the area of foliar fertilizer spraying. This research focuses on increasing the UAV's lift capacity and designing a UAV system equipped with a sprayer. The increase in lift is related to the payload to be carried by the UAV. This research targets to optimally increase the load of liquid foliar fertilizer. In this research, the UAV was designing using a multi-rotor type. The measurements taken are the success rate of the system in flying over the crop field, testing the measurement of power, current, battery capacity, and different loading 40, 45, 50, 55 percent of the total weight from an unmanned aerial vehicle.

1. Introduction

Multicopter unmanned aerial vehicles are the most research objects, one of which is in agriculture. Multicopter can conduct land surveys, remote monitoring, or other activities to facilitate agricultural activities, especially for spraying pests and fertilizing. Fertilization is more concerned with liquid Fertilization, which is directly spraying on the leaves, or it is also called foliar fertilizer. Foliar fertilizer is spraying, hoping that the stomata on the leaves can directly absorb the nutrients given. The UAV will fly carrying liquid (liquid) foliar fertilizer and spraying it on a predetermined land using a flight path that has been programmed in the UAV [1].

In previous research, we have used a multicopter type Unmanned Aerial Vehicle (UAV) combined with a foliar spraying system with a 1-liter liquid fertilizer with the best flight altitude settings on agricultural land [1]. We continue researching UAV with foliar fertilizer in the section on altitude optimization by adding a sonar sensor as a vehicle height sensor [2]. 1L liquid capacity is only able to



spray land with a limited area. The limited liquid capacity will be a problem for the UAV because it is necessary to fill the liquid many times if used to spraying a wider area. Therefore it is necessary to optimize the liquid load on the UAV so that its capacity will increase. If UAV's liquid foliar fertilizer's capacity increases, it will increase the area of foliar fertilizer spraying.

Previous research has been doing using UAVs to facilitate agricultural activities. Even the spraying capability is limited to crop protection [4] and flight speed, spraying rate at the targeted surface droplet deposition density. This research aims to evaluate operating parameters such as UAV flight speed. Trials were carried out using UAVs with different flight speeds (2.6 & 6 m / s), at a constant altitude of 2 m above rice plants using foliar fertilizer, with different spraying speeds. (0.75, 1.5, 2.25 and 3.00 L / min) used water-sensitive paper as samples and analysed statistically. The experimental results show that droplet uniformity and droplet deposition density are higher when the UAV flight speed is maintained at a lower speed (2 m / s) compared to higher flight speeds (4 and 6 m / s) [5][6].

In this research, the load of liquid foliar fertilizer is maximizing, where with the additional load. It is expecting that the UAV can cover a broader area in the foliar fertilizer spraying process. In the previous research, by carrying a load of 1 L of liquid foliar fertilizer, the altitude, latitude, and longitude coordinates were set based on the PID so that the UAV could run according to the expected track [8]. The additional load on foliar fertilizer affects the lifting capacity of the UAV. The UAV in this research is a multirotor type. The multirotor lift is influenced by the amount of force each motor [9]. Each of these motors has a propeller, which functions to exert pressure on the UAV down to lift in the UAV [3]. If the liquid load is added to the UAV, it is necessary to know the liquid load to be added so that the UAV power can be designed to lift the load. The design of the UAV system includes a library on the principle of thrust, liquid foliar fertilizer, and a sprayer system for spraying liquid foliar fertilizer onto land. (fig. 1).



Figure 1. Unmanned aerial vehicle

2. Material and methods

This research focuses on increasing the load capacity of foliar fertilizer and the design of the UAV system equipped with a sprayer. The increase in load is related to the payload to be carried by the UAV. This research targets to be able to lift the burden of liquid foliar fertilizer more than the capacity of the previous research. 5 L liquid load is used as pay load. UAV can lift this load with the equipment and components that are in the UAV, in this case it is used as the UAV empty weight. If the calculation of pay load and empty weight is added up and then added by 40% of the total amount, the total force will be obtained which can lift the UAV. In this research, the UAV was designed using a multi-rotor type, the Hexacopter model, which is a multirotor which has six motors and a propeller.

The design of the UAV system shown in Figure 2 is equipped with a sprayer. The UAV drive system uses six motors (M1-M6) controlled by each ESC [7]. ESC (electric speed controller) functions to regulate motor rotation based on control from the flight controller. On the other hand, the sprayer system is also controlled from the flight controller via the driver [3]. The driver controls the sprayer motor, which pumps the liquid in the liquid tank to be sprayed through the nozzle. The flight controller is based on information from compass and GPS sensors, barometer sensors to control the running of the UAV. The flight controller receives commands in the form of longitude and latitude (way point) coordinates from the GCS (Ground Control Station). GCS in this case is a PC (personal computer) running mission planner software. Telemetry using a 433Mhz frequency functions to connect the Flight controller with GCS. TX remote functions to control the UAV mission mode connected to the Flight controller via the RX with a frequency of 2.4 GHz

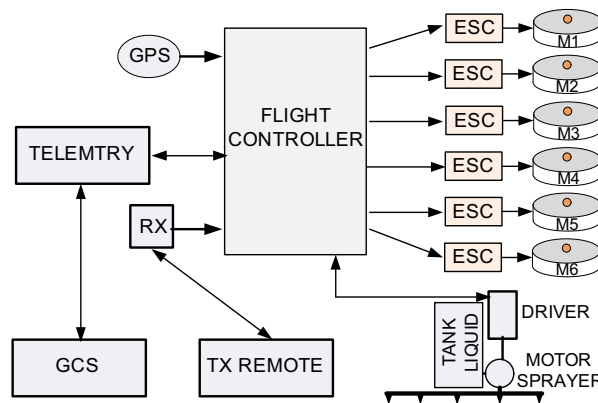


Figure 2. Design of UAV with load optimization

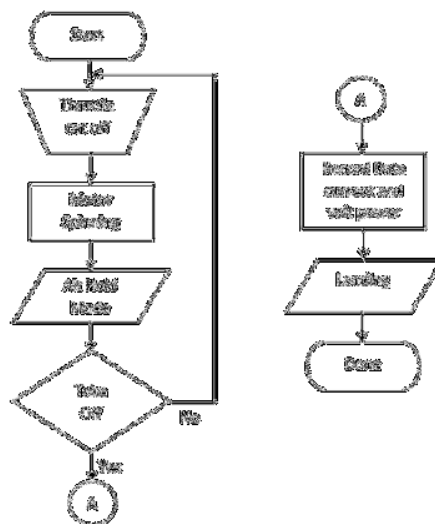


Figure 3. Flowchart Liquid Load Optimization UAV

At the test stage, given different loads, the load is 40, 45, 50, 55 percent of the total weight of the unmanned aerial vehicle, measuring in-flight and testing flight stability, power, current, battery capacity. The preparation and initialization process connects UAV communication with the program on the computer and then gradually optimizes the UAV process load as shown in Figure 3. At the test stage, with different loads capacity, the load is 40, 45, 50, 55 percent of the total weight of the unmanned aerial vehicle, measuring in-flight and testing flight stability, power, current, battery capacity. The preparation and initialization process connects UAV communication with the program on the computer and then gradually optimizes the UAV process load as shown in Figure 3.



Figure 4. Track Waypoint

The UAV is operated in altitude hold mode until it reaches a certain altitude, then switches to automatic mode, automatic mode is the state of flying the UAV by carrying out a flight mission with a predetermined waypoint and altitude, if the mission is complete, the UAV will land according to its longitude latitude location point. If the mission has not been completed and there is a problem with the UAV, for example, low battery capacity or a problematic compass, the UAV will return to the specified latitude longitude location point as shown in Figure 4.

3. Result and discussion

From the results of each experiment, the current data shows a sharp rise at 55% loading, stable current conditions at 50% to 45% loading, the current condition drops at 40% loading. In the UAV voltage measurement with a loading of 55%, it also shows a decrease from 24.5 to 22.0, this shows the UAV is lifting heavy loads. The voltage with a decrease from 24.5 to 22.5 with a loading of 40% to 50% indicates that the UAV can lift loads but can survive. The result of load optimization for liquid fertilizer can be optimized up to 50% of the total Thrush motor UAV.

The calculation of the maximum load can be lift by the power of the motor, frame (Hexacopter frame), water tank, then the installation of electronic components and controls, the installation of a Watt meter as a power measurement tool. After the various preparations have been complete, it continues with a flight trial based on the calculation of the percentage between the motor lift/motor thrust and the total weight of the UAV. Flight trials done with a percentage of 40%, 45%, 50%, and 55% of the total load from the UAV. The process of flying does with an average height of 2 meters from the ground using altitude hold mode (ALT HOLD)—the process of reading the maximum UAV current, UAV voltage, and UAV power.

The UAV flight control system in this research uses a mini pixhawk. The first experiment show in Table 1 done a maximum weight of 55%, namely 6.6 Kg of the total thrust of the motor 12 Kg, then 50%, 45% and 40%. In this research, we can maximum reduce the total weight of the UAV by up to 40% because dropping this value will reduce the UAV frame.

Table 1. The results of measuring the optimization of the UAV load on the thrust motor

Experiment	Load / thrust	Load	Vstart	Vstop	Vmin	Imin	Imax	Wp
1	55%	6.60	24.26	24.08	22.88	0.27	66.00	1595.22
2	50%	6.00	24.14	23.99	23.10	0.30	54.16	1261.30
3	45%	5.40	24.08	23.90	23.17	1.28	51.54	1197.70
4	40%	4.80	24.01	23.80	13.12	0.27	43.14	1003.00

Table 1 shown the compares of current and voltage values of the UAV when the vehicle is flying. By comparing the value of voltage and current to each load being test, it will show the load selection, which shows the average increase in current and voltage drop (according to the motor datasheet). The behaviour of an increased current or decrease voltage that occurs when the UAV is flying indicates whether or not the UAV is loaded.

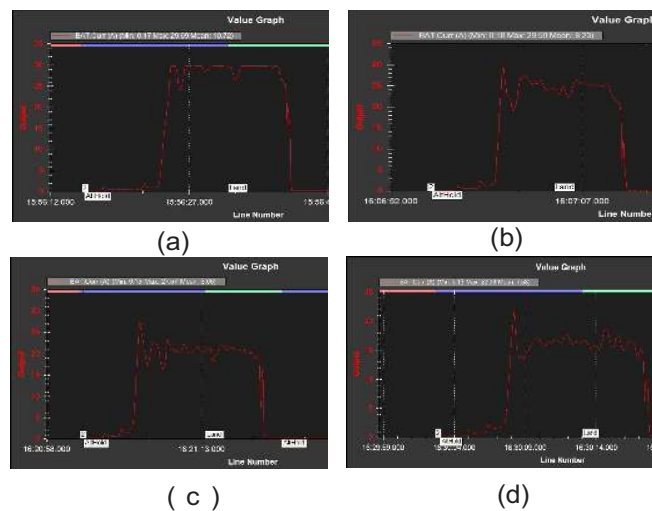
**Figure 5.** Flow graph current UAV

Figure 5 part (a) shows the current graph at 30A with a motor load and thrush ratio of 55%, then sections (b) and (c) show a current graph that is not much different in the range 20-25A with a load and thrush ratio of the motor 50 - 45%. The smallest in section (d) shows a current graph below 20A; this shows the less than maximum power on the motor. The voltage measure UAV with a loading of 55% also shows a decrease from 24.5 to 22.0; this indicates that the UAV is lifting heavy loads. The voltage decrease from 24.5 to 22.5 with a loading of 40% to 50% indicates the UAV can lifting loads.

4. Conclusion

From the results, the current data shows a sharp load rise at 55%, stable current conditions at 50% to 45%; the current condition drops at load 40%. The voltage measurement of a UAV with a load of 55% shows a decrease from 24.5 V to 22.0 V; this indicates that the UAV is lifting heavy loads. The voltage decrease from 24.5 to 22.5 with a load of 40% to 50% indicates the UAV can lifting loads. The result of load optimization for liquid fertilizer can be optimized, up to 50% of the total Thrush motor UAV.

Acknowledgments

The author would like to thanks PNPB fund research program, number: 443 / PL17.4 / PG / 2020 has supported this research.

References

- [1] I. Soelaksini, L D; Purnomo, F E; Afriansyah, F L; Muna, N; Widiastuti 2018. Optimization of Flight Track Autonomous on Precision Farming Using Unmanned Aerial Vehicles For Foliar Farming pp. 5–9,
- [2] I. Widiastuti, N. Muna, F. L. Afriansyah, and F. E. Purnomo 2019 Automatic Image Stitching of Agriculture Areas based on Unmanned Aerial Vehicle using SURF pp. 388–393,.
- [3] F. L. Afriansyah, N. Muna, I. Widiastuti, N. Z. Fanani, and F. E. Purnomo, 2017 Image Mapping Detection of Green Areas Using Speed Up Robust Features,” pp. 2–5,
- [4] M. Nurfaiz 2019 Droplet deposition density of organic liquid fertilizer at low altitude UAV aerial spraying in rice cultivation,” vol. 167, no. October,
- [5] M. Mozaffari, W. Saad, M. Bennis and M. Debbah, "Unmanned Aerial Vehicle With Underlaid Device-to-Device Communications: Performance and Tradeoffs," in IEEE Transactions on Wireless Communications, vol. 15, no. 6, pp. 3949-3963, June 2016, doi: 10.1109/TWC.2016.2531652.
- [6] M. Huang, B. Xian, C. Diao, K. Yang and Y. Feng, "Adaptive tracking control of underactuated quadrotor unmanned aerial vehicles via backstepping," Proceedings of the 2010 American Control Conference, Baltimore, MD, 2010, pp. 2076-2081, doi: 10.1109/ACC.2010.5531424.
- [7] Z. Song, H. Zhang, F. Liu, S. Chen and F. Zhang, "Unmanned Aerial Vehicle Coverage Path Planning Algorithm Based on Cellular Automata*," 2018 International Conference on Information Systems and Computer Aided Education (ICISCAE), Changchun, China, 2018, pp. 371-374, doi: 10.1109/ICISCAE.2018.8666895.
- [8] F. L. Afriansyah, F. E. Purnomo, N. Z. Fanani, I. Widiastuti, and N. Muna, “Altitude Optimization Using Ultrasonic Sensors Of Unmanned Aerial Vehicle For Foliar Fertilizer,” pp. 156–160, 2019.
- [9] F. Zakharin and S. Ponomarenko, "Unmanned aerial vehicle integrated navigation complex with adaptive tuning," 2017 IEEE 4th International Conference Actual Problems of Unmanned Aerial Vehicles Developments (APUAVD), Kiev, 2017, pp. 23-26, doi: 10.1109/APUAVD.2017.8308768.