Plant Biosecurity and Biodiversity in Dryland Areas in a Time of Climate Change

Collected papers

Kupang, East Nusa Tenggara, November 2019

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About the APBSF, plant biosecurity, and this proceedings

The Australian Plant Biosecurity Science Foundation supports plant biosecurity research, development, extension and capacity building, particularly focused where there is a need for investment in environmental, capacity building, international linkages, non-levy payer, cross-sectoral and strategic plant biosecurity research. The Foundation was established to follow the Plant Biosecurity Cooperative Research Centre (PBCRC) which finished operations in June 2018.

Plant Biosecurity is a set of measures designed to protect a crop, crops or a sub-group of crops from emergency plant pests at national, regional and individual farm levels. Plant Biosecurity is a global issue. Harmful plant pests and diseases can impact on our unique environment and biodiversity, food safety, agricultural trade and market access.

This proceedings is a compilation of papers presented at a Regional Master Class held in Kupang, Nusa Tenggara, from 19 to 23 November 2019, following the first in this series of two, held at Salatiga, Indonesia, in February 2019.

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- East Timor Coffee Institute
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CONTENTS

FOREWORD

In the on-going national and international debate and discussion about meeting the global imperatives of securing food security and food sovereignty, a vital objective is that regional and local connotations, challenges and opportunities shall be very much 'front of mind'.

The International Master Class (IMC) in Plant Biosecurity held in Denpasar, Bali, in January 2018 brought together participants from many parts of the vast Indonesian archipelago. One of the principal outcomes of two weeks of concentrated activity was the overwhelming support for projecting biosecurity thinking into Indonesian regions. This was seen as a cost-effective way of facilitating out-reach, thus achieving the objective. The need for a pro-active approach to biosecurity by all sectors has become even more prominent with the shock-wave caused by the current, global, pandemic of COVID-19, the coronavirus.

The network which was established following the Denpasar IMC has remained very active, generating several proposals for Regional Master Classes (RMC). Following a successful RMC at Salatiga, Central Java, early in 2019, a second was completed in November in Kupang, East Nusa Tenggara, hosted by Universitas Nusa Cendana (UNDANA) and the Australian Plant Biosecurity Science Foundation.

To complement local input, keynote speakers were engaged from the Australian National University, CABI and the University of Queensland. Further input was provided by the Indonesian Institute of Sciences (LIPI), the Indonesian Biosecurity Foundation (IBF) and local members of staff of UNDANA.

Several keynote speakers addressed issues of significance in the context of the RMC theme 'Plant Biosecurity and Biodiversity in Dryland Areas in a Time of Climate Change'. Additional papers were presented concerning aspects of biodiversity, including a number of potential or little-known crops; the changing role of women in agriculture; community-based attitudes to climate change; multidisciplinary approaches to climate change, and capacity building, including information literacy improvement for farmers, as summarised in this proceedings.

In addition to highlighting key aspects pertaining to food security and food sovereignty, these two RMCs have: (i) helped to grow the network established following the IMC of 2018; (ii) raised the profile of the Indonesian Biosecurity Foundation as a peak body for the nation; (iii) further strengthened bilateral ties with Australia; and (iv) through CABI, cemented linkages to the rest of the biosecurity world.

The Editors: John Lovett
Sri Widinugraheni
Ann Milligan

Canberra and Kupang, March 2020

Presenters and participants at the Regional Master Class held at Kupang, East Nusa Tenggara, in November 2019. *Photo*: Widinugraheni 2019.

PRESENTERS

Professor Fred Benu, Rector of Nusa Cendana University, Kupang (2013–2021), is a former Head of Research Centre in UNDANA and well known for his research with traditional fisherman in Rote island – an alternative livelihood to illegal fishing activities in the Indonesian–Australian trans-boundary waters.

Dr Arnaud Costa is a CABI Associate, agronomic consultant, researcher and lecturer with experience and knowledge in Integrated Pest Management (IPM), Invasive Pests, Chemical Ecology, Biological Control and Agro-ecology. His research is in entomology, and he is an auditor or adviser for farmers and extension.

Professor Andre Drenth is Professorial Research Fellow, Centre for Horticulture Science, Queensland Alliance for Agriculture and Food Innovation (QAAFI), The University of Queensland, Brisbane. He has expertise in agricultural plant science, and has many publications, including over 130 journal articles as well as 50 conference papers, a newspaper article, book chapters and research reports.

Professor Ian Falk is formerly of Charles Darwin University, a long-time resident of Denpasar and associated with Universitas Mahasaraswati Denpasar (UNMAS). He has interests in sociology and rural sociology; regional and community development; community capacity building; social capital; adult learning and learning communities.

Eng Lucio Marçal Gomez is Chancellor of East Timor Coffee Institute (ETCI), and was Director East Timor Coffee Academy (ETICA) during 2003–2012.

Don Harrison Kadja, SP, MSc, works on pests management with a wide range of government institutions and NGOs at national and international levels. Don Kadja established the Remote Microscope facility at UNDANA in 2017. He is currently Secretary of the Agrotechnology Department of Facultas Pertanian UNDANA.

Dr Maria Lobo, Head of International Relations at Nusa Cendana University, Kupang, is a senior lecturer in the Department of Mathematics. She is in charge of facilitating and developing collaboration works between international institutions and UNDANA under the coordination of the Vice Rector for Cooperation.

Professor John Lovett is Chair, Australian Plant Biosecurity Science Foundation and Chair, Australian Research Council Centre of Excellence in Translational Photosynthesis. Formerly he was Foundation Chairman of the Plant Biosecurity Cooperative Research Centre, and Managing Director of the Grains Research Development Corporation. His interests are in crop protection and plant biosecurity.

Ms Jenny E.R. Markus has 25 years' experience in research and community development, working with government institutions, NGOs and INGOs, as well as communities in East Nusa Tenggara and Lampung. Her research with various crops and foods supports food security and food diversity, as well as biodiversity and biosecurity and climate change in dryland.

Dr Yosep Seran Mau has a Bachelors degree in Agronomy, a Masters in Plant Science and Plant Pathology and a PhD in Molecular and Microbial Sciences. He works on plant resistance to pathogens and pests of food crops such as upland rice, sweet potato and pulse crops, including the diverse local food crops in NTT province. His publications appear in international and national academic journals, and conferences.

Melinda R.S. Moata, with a PhD in Agriculture and Natural Resource Management, is a lecturer and senior researcher, working on a circular economy, dryland management systems, land quality and capability, and climate smart agriculture. She frequently leads collaboration between private sector institutions (NGOs) and universities, within Indonesia and abroad, such as in dealing with climate adaptation.

Dr I. Wayan Mudita, M.Sc. PhD (with the CRC for National Plant Biosecurity), has worked with a range of government institutions and NGOs at national and international levels in developing a collaborative approach to natural resources, fire, and invasive species management. He has acted as Director of a number of research centres at UNDANA where he is currently Deputy Rector, Partnership.

Mr I. Wayan Nampa is a social economic scientist in the Faculty of Agriculture, Department of Agribusiness, Universitas Nusa Cendana (UNDANA). His research interests are in socio-economic and rural development, especially in agriculture, regionally and internationally. His recent studies on on social and economic development in dryland areas have looked at artisanal and small-scale mining in relation to rural livelioood s.

Dr.rer.nat. Antonius R.B. Ola is a lecturer in the Chemistry Department and a staff Scientist in the integrated centered laboratory (BIOSAINS) of Nusa Cendana University. He leads investigations on bioactive natural products from microbes, plant and marine organisms for applications in medicine and agriculture. Dr Ola has received international publication awards, and he holds registered international and national patents.

PRESENTERS continued

Professor Barry Pogson, Deputy Director of the ARC Centre of Excellence in Plant Energy Biology, is Chief Investigator on an International Wheat Yield Partnership grant to Improve Wheat Yield by Optimising Energy Use Efficiency. Not only is he a highly cited scientist and much awarded author and editor, his group also has received national awards for research, teaching and supervision excellence.

Titi Susilowati Prabawa, PhD, is a lecturer in the graduate program of Development Studies and Head of the Tourism Department and Head of the Sustainable Development Research Centre at Satya Wacana Christian University. Her research relates to the micro-economy at the level of enterprises and individual entrepreneurs, and the social, political and cultural environment of the economics of entrepreneurship.

Norman P.L.B. Riwu Kaho, SP, MSc, a lecturer in UNDANA, interested in GIS and SAGA, is well known for his work on mapping and spatial analysis, including many collaborative works between UNDANA and NGOs. His publications include papers in the *International Journal of Research in Electronics and Computer Engineering* (2017) and the *International Symposium on Geoinformatics* (2017).

Professor Enny Sudarmonowati is a key figure in the UNESCO Man and the Biosphere (MAB) program in Indonesia, and the Indonesian Institute of Sciences (LIPI), and a member of the Biosafety National Commission. Her research is on genetic conservation and improvement of plants. She has over 200 scientific publications, 2 granted patents, 3 registered patents and 2 Plant Variety Protections (PVTs).

Linda Susilowati is a social scientist based at Satya Wacana Christian University. She researches and runs projects in women's empowerment, cultural studies, rural area development and community engagement. Linda is Managing Editor of *KRITIS: Journal of Interdisciplinary Studies*; a member of the Bilateral Plant Biosecurity Initiative (Indonesia–Australia), and Liaison Officer for the Indonesian Biosecurity Foundation.

Sri Widinugraheni, SP.M.Sc., is a lecturer at Nusa Cendana University, Kupang. She has a Bachelors degree in Agronomy and a Masters in Phytopathology, and is currently researching host–pathogen interactions, of *Fusarium* wilt in bananas for a PhD and also in other horticultural crops. She publishes in international journals and conferences, and has worked on diseases in citrus at the USDA, Florida, USA.

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MASTER CLASS PROGRAM, 18–23 November 2019

Day 1. 18 November 2019 (Monday): International Seminar

08.30 – 09.00	Conference Opening Ceremony
09.15 – 10.45	Keynote address: Professor Fred Benu, Rector of Nusa Cendana University
	Keynote address: Professor Barry Pogson, The Australian National University
	Keynote address: Professor Enny Sudarmonowati, Indonesian Institute of Sciences (LIPI)
10.45 – 12.15	Keynote address: Professor Andre Drenth, The University of Queensland
	Keynote address: Dr Arnaud Costa
	Keynote address: Eng. Lucio Marcel Gomez, M.Eng., Rector of East Timor Coffee Institute
13.30 – 16.00	Three parallel sessions, each of 10 short oral presentations –
	A: Dryland Production Systems in a Time of Climate Change, *and* Community Roles in Managing Biodiversity and Biosecurity in a Time of Climate Change
	B: Biodiversity and Biosecurity Risks and Responses in a Time of Climate Change
	C: Plant Ecosystem and Plant Genetic Diversity, and other related fields.
16.00 – 17:00	Synthesis and Closing Ceremony.

Day 2. 19 November 2019 (Tuesday) International Master Class

09.00 – 09.30	Master Class Opening Ceremony
09.30 – 10.30	Orientation; desired outcomes of Master Class, led by Prof. John Lovett & Dr I. Wayan Mudita
11.00 – 12.00	Dryland Production Systems in Nusa Tenggara in a Time of Climate Change, led by Prof. Enny Sudarmonowati
13.30 – 14.30	Impact of climate change on dryland systems, led by Professor Barry Pogson
15.00 – 16.00	Biosecurity and Biodiversity: why are they important? Interactive discussion with the participants led by Professor Ian Falk and Dr. I Wayan Mudita
16.00 – 17.00	Workshop Groups 1: Common themes and where we differ, facilitated by Dr Arnaud Costa
17.00 – 18.00	Workshop Groups 2: How can we adapt dryland production systems to climate change?, facilitated by Professor Barry Pogson

Day 3. 20 November 2019 (Wednesday)

08.00 – 08.30	Review previous day's activities, led by Professor Ian Falk and Dr. Maria Lobo
08.30 – 09.30	Participants' presentations: Impacts of climate change on dryland production systems, facilitated by Professor John Lovett
09.30 – 10.30	Understanding biosecurity and biodiversity risk in a time of climate change, led by Dr Arnaud Costa
11.00 – 12.00	Responses to risk in a time of climate change, led by Dr Arnaud Costa
13.30 – 14.00	Simulation exercises, led by Mr Norman Riwu Kaho (UNDANA) and Dr Yosep Seran Mau
14.00 – 14.30	Banana biodiversity and biosecurity, led by Professor Andre Drenth, the University of Queensland
14.30 – 15.30	Coffee biodiversity and biosecurity, led by Eng. Lucio Marcel Gomez, M.Eng., Rector of East Timor Coffee Institute
15.30 – 16.30	Discussion of approaches to these important crops. Lessons for other crops, led by Prof. John Lovett
16.30 – 17.30	Workshop Groups: How can we help to limit the impact of climate change on dryland cropping systems? led by Dr Melinda Moata
17.30 – 18.00	Assistance on writing Case Studies (RMC Team) (Dr Antonius Ola and Prof. John Lovett)

Day 4. 21 November 2019 (Thursday)

08.00 – 12:00	Field visit: banana biodiversity, cropping systems, and biosecurity
13.30 – 14.30	Community Involvement in ensuring biosecurity and protecting biodiversity, by Professor Ian Falk
14.45 – 15.45	The Growing Role of Women in Dryland and Other Production Systems, by Ms Linda Susilowati
15.45 – 16.45	Discussion on role of women and community engagement in biodiversity and biosecurity awareness raising, led by Professor Ian Falk
16.45 – 17.30	Lessons learned from using social media for community awareness raising of biodiversity and biosecurity, by Mr. I Wayan Nampa and Dr. I Wayan Mudita (UNDANA)
17.30 – 18.00	Assistance on writing Case Studies (RMC Team) (Dr Antonius Ola and Prof. John Lovett)

...continues on next page

Day 5. 22 November 2019 (Friday)

08.00 – 08.30 Review of previous day's activities, led by Ms Sri Widinugraheni and Dr Maria Lobo

08.30 – 09.30 Roles of local food crops in supporting food security in dryland areas, led by Ms Jenny Markus

09.30 – 10.30 Promoting Local Food Through Tourism Development, led by Dr Titi Susilowati Prabawa

13.30 – 14.30 Open Access GIS as a tool in managing biodiversity and biosecurity in dryland areas, by Mr Norman Riwu Kaho (UNDANA)

15.00 – 16.00 Lessons learned from using remote microscope in biodiversity and biosecurity awareness raising in dryland areas, by Mr Don Kadja (UNDANA)

16.00 – 17.00 Discussion on integrating open access GIS, remote microscope, and social media in managing biodiversity and biosecurity in dryland areas, led by Mr Norman Riwu Kaho (UNDANA) & Dr Yosep Seran Mau (UNDANA)

17.00 – 17.30 Assistance on writing Case Studies (RMC Team) (Dr Antonius Ola and Prof. John Lovett)

Day 6. 23 November 2019 (Saturday)

08.00 – 08.30 Review of the week's activities led by Professor John Lovett and Dr I Wayan Mudita

08.30 – 10.00 Where to next? led by Professor Ian Falk and Ms Linda Susilowati

19.30 – 10.45 The Indonesian Biosecurity Foundation, update by Professor Ian Falk

10.45 – 11.00 The Australian Plant Biosecurity Science Foundation, update by Prof. John Lovett

11.00 – 12.00 Closing Ceremony and presentation of Regional Master Class Certificates.

Top: East Nusa Tenggara in Indonesia (red coloured areas), *from Wikimedia commons*.
Below: Nusa Tenggara Timur (East Nusa Tenggara),
from CartoGIS Services, College of Asia and the Pacific, The Australian National University.

DRYLAND PRODUCTION SYSTEMS IN A TIME OF CLIMATE CHANGE

1. ***Jenny E.R. Markus***
   Roles of local food crops in supporting food security in dryland areas

2. ***Akhmad Syafruddin & Esra D.N.A. Benu***
   Study of agriculture policy about agriculture and its protection and management in dryland areas

3. ***Helena da Silva, Yohanes L. Seran & P. Rudlof M***.
   Water supply investment analysis for maize farming development in dryland: a case study of Oeteta Village, Sulamu District, Kupang Regency

4. ***Yohanes Leki Seran, Helena da Silva & P. Rudlof Matitaputty***
   Water supply through air vacuum technology and Tamren irrigation system in dryland for supporting a horticulture farming system

5. ***Widasari Bunga***
   Identification of drought tolerance in soybean cultivars using a stress susceptibility index

6. ***Mamie E. Pellondo'u***
   Utilisation of organic pots with sand as media for growing semin sengon

1. ROLES OF LOCAL FOOD CROPS IN SUPPORTING FOOD SECURITY IN DRYLAND AREAS

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Abstract

Local food crops are valuable in helping achieve the food diversification program. They include carbohydrate sources such as rice, maize, sweet potatoes, cassava, foxtails, yams, banana, taro, and others; and protein sources such as dolichos beans, mungbean and red bean. Coconut and candlenut are fat sources as well as good sources of minerals and vitamins. Local food crops can improve the income of the community throughout the province of East Nusa Tenggara. As well, some research has been done to identify drought-tolerant cultivars of crops such as upland rice and sweet potato, as well as some processed foods based on gewang starch, and local beanflour.

Keywords: local food crops, food security, dryland area, diversity

Abstrak

Pangan lokal telah dimanfaatkan oleh masyarakat sejak lama. Sumber pangan lokal digalakkan untuk mencapai program keragaman pangan di Indonesia. Sumber karbohidrat seperti padi, jagung, ubi kayu, ubi jalar, uwi, pisang, keladi, gayong, suweg. Sumber Protein seperti aneka kacang seperti kacsng hijau, kacang merah, kacang komak, sumber lemak dan minyak seperti kelapa, kemiri, juga sumber mineral dan antioksidan seperti labu. Untuk meningkatkan pendapatan masyarakat juga dapat mengembangkan jenis jenis tanaman sumber pangan lokal ini. Oleh karena itu beberapa penelitian telah dilakukan seperti pengembangan padi gogo tahan kering, ubi jalar tahan kering dan pemenafaat tanaman lain seperti gewang.

Kata kunci: pangan lokal, ketahanan pangan, lahan kering, keragaman makanan

Introduction

'Food security is commonly defined as the physical, social and economic ability to access sufficient, safe and nutritious food' to meet people's dietary needs and food preferences for an active and healthy life. 'The four pillars of food security that are intrinsic to this definition are availability of food, stability of the food supply, access to adequate food and utilisation of food' (FAO 1996, 2008).

The four main dimensions of food security are: food availability (consistent, adequate quantity of food); food accessibility (both physical and economic access to food); food utilisation (appropriate use-based knowledge regarding nutrition, water, and sanitation); and stability of those three dimensions over time (FAO 1996, 2008).

Food crops are mainly classified by the main type of nutrition they produce, such as carbohydrate, protein, fat, minerals, vitamins, water and fibre. Antioxidants in food can ensure adequate macro- and micronutrient uptake from the food sources (carbohydrates, protein, fats, vitamins and minerals).

By contrast, food insecurity occurs when there is limited or uncertain availability of nutritionally adequate and safe foods, or limited or uncertain ability to acquire such foods in socially acceptable ways. Food insecurity can have very large impacts on people's physical and mental health status. Food security and public health can be difficult to achieve and sustain if the population is undernourished and at risk of starvation (Charlton 2016; Nurbaya 2018).

Approach

We aimed to identify locally important food crops. First we collected seeds around East Nusa Tenggara; then we selected crops that are planted locally.

Next, in a qualitative approach, we interviewed local people about their access to food and how they cope with food insecurity. The informants were women and men who were responsible for food preparation at home. Information gathered included the key informant's age, type of family, number of children, and how the family ensures their food has adequate nutritional status.

To identify local plants we collected samples of crops: seed of rice, maize, foxtails and millets; tubers of sweet potatoes (*Ipomoea batatas*), yam (*Dioscorea* sp.), suweg (*Amorphophallus campanulatus*) and taro (*Colocasia esculenta*); stems for cassava (*Manihot esculenta*). These collections are to enhance the sources. Data collected included GPS coordinates and photos of each part of each crop. Processed foods were recorded variably according to the research objectives.

The people who were interviewed had all signed an informed-consent form; the interviews were recorded using voice recorder.

Information about the nutrition provided by the local foods, and best methods of processing them, was obtained by chemical analysis at a laboratory.

Discussion

A number of food crops that tolerate dryland conditions have important roles locally in human nutrition. Sorghum, yam and taro, sweet potato and gewang (*Borassus flabellifer*, Palmyra palm) are mainly eaten as sources of energy. For sorghum, in particular, about 31 cultivars are grown locally, especially in 6 districts in East Nusa Tenggara (Mukkun et al. 2018): East Flores, Lembata, Rote Ndao, Saburaijua, Kupang and Belu. In East Flores, some processed foods are produced from a sorghum base, such as sorghum analogue rice, instant sorghum, sorghum flour, noodles, bread and other ready-to-eat products (Markus & Hali 2018; Mukkun et al. 2018). Similarly, about 32 local upland rice cultivars (Seran et al. 2016) and 22 sweet potato cultivars are grown around East Nusa Tenggara (Seran et al. 2019).

As protein sources, local food crops include dolichos, pigeon pea, red bean, Fore Belu mungbean, and redgrain *Cayanus cayan*. In Timor, about 17 cultivars of local dolichos bean (Markus et al. 2009) can be identified based on colour of the bean skin. Fats are mainly sourced from coconut and candlenut, while pumpkins, cassava leaves and sweet potato leaves can supply vitamins and minerals.

Other local processed foods eaten include tiwul instant from Sikka district, rice analogue, biscuit, cake, cookies, noodles, macatale, mietale from Ngada district, and maie analogue rice from Kupang district (Markus & Kaho Bunga 2019).

Apart from their role in nutrition, some local food crops, such as gewang, can be used in cultural ceremony, in Belu and Malaka West Timor for example. Here, gewang has benefits not only in foods such akabilan analogue rice, noodles, cookies or biscuits, but also in every cultural ceremony (Markus et al. 2009; Markus & Hali 2018; Markus & Kaho Bunga 2019).

Future work

Local food crops are important in meeting food security needs in dryland areas, by making food available to households. By growing the crops themselves, households have access to nutritious and safe food at low cost, which increases the households' food security status. Therefore, there needs to be dissemination of information about the nutritional benefits provided by each potential food crop, to increase knowledge and awareness and enhance biodiversity and biosecurity.

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2. STUDY OF AGRICULTURE POLICY ABOUT AGRICULTURE AND ITS PROTECTION AND MANAGEMENT IN DRYLAND AREAS

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Abstract

This study aims to explain the public policy in agriculture and dryland management specifically as a solution to the reduction of productive agricultural land. This research was conducted through a literature study, and data collection was carried out by identifying keywords or information related to agricultural policy and more specifically related to dryland management. The results showed that the Government has made many agricultural policies but none specifically for the management of dryland areas. Forms of policy that have been carried out include relating to inventory, identification, and verification of fertile and dryland data, establishing sustainable agricultural areas, building infrastructure, empowering, subsidising, and preventing price inflation. Policies related to agricultural land management have not been the focus of the Government.

Keywords: policy, government, agriculture, dryland

Abstrak

Penelitian ini bertujuan untuk menjelaskan kebijakan publik di bidang pertanian dan pengelolaan lahan kering secara khusus sebagai solusi atas berkurangnya lahan pertanian produktif. Penelitian ini dilakukan melalui studi pustaka dan pengumpulan data dilakukan dengan cara mengidentikasi kata kunci atau informasi terkait kebijakan pertanian serta lebih khusus terkait pengelolaan lahan kering. Hasil penelitian menunjukan bahwa pemerintah telah banyak membuat kebijakan pertanian namun khusus pengelolahan lahan kering belum dilakukan. Bentuk kebijakan yang telah dilakukan diantaranya terkait inventaris, identifikasi, dan verifikasi data lahan subur dan lahan kering, menetapkan kawasan pertanian berkelanjutan, membangun infrastruktur, pemberdayaan, subsidi, dan mencegah inflasi harga. Kebijakan terkait pengelolaan lahan pertanian belum menjadi focus pemerintah

Kata kunci: kebijakan, pemerintah, pertanian, lahan kering

Introduction

The Government's big vision in agriculture is to create food security and community welfare. To realise this vision, the Government faces various threats that can affect national food availability. These threats include climate change that can cause drought; conversion of agricultural land into residential land; landslides and erosion; land degradation; land ownership by a group of people and industry.

To overcome the above threat the Government made a policy for increasing agricultural output, reducing imports and increasing national food exports. This effort can be seen from the various regulations that have been made and, more importantly, that can be implemented well. Some of the policies that have been issued by the Government are:

- law number 41 of 2009 concerning the protection of sustainable agricultural land, which has been followed up through Government regulation number 01 of 2011 concerning the establishment and transfer of agricultural and food land functions;
- Government regulation number 12 of 2012 concerning land protection incentives for sustainable food agriculture;
- Government regulation number 25 of 2012 concerning information systems for sustainable agricultural land; and
- Government regulation number 30 of 2012. The policy objective here involves the Government preparing and managing agricultural land so that it can be maximally utilised by farmers.

In conducting counselling guidance to farmers the Government made law number 16 of 2006 concerning agricultural, fisheries and forestry extension systems. Through this regulation, the Government built counselling centres at the provincial, district and sub-district levels.

Regarding the empowerment of farmers, the Government issued law number 19 of 2013, concerning the protection and empowerment of farmers. This empowerment aims to improve the skills of farmers in managing agricultural land.

To accelerate the construction of dam infrastructure, the Government issued Presidential instruction number 01 of 2018 regarding the acceleration of the provision of small reservoirs and other water storage structures in villages. The aim of establishing infrastructure development is to make water available in agricultural lands.

From some of the explanations above, the writer is very interested to know seriously about policies in managing agriculture and dryland.

Approach

This study uses qualitative methods: library research, collecting data or scientific papers that aim at the object of research, and collecting data that is in literature or studies carried out to solve a problem, based on a critical and in-depth study of relevant library materials.

A literature study, besides looking for secondary data sources that will support research, is also needed to find out to what extent the science associated with research has developed, and where some conclusions and generalisations have been made so that the necessary situations are obtained.

Information can be obtained from several sources including textbooks, scientific journals, statistical references, research results in the form of theses and dissertations, and the Internet, as well as other relevant sources such as regulations relating to Government policy in the agriculture sector.

The main purpose of a literature study is to organise the findings of researches that have been conducted, to understand why a problem or theme is raised in a study, and how the results of the research can be linked to broader knowledge.

The objectives to be achieved in this study are to identify policies of the central Government and regional governments related to improving the agricultural sector, and specifically on how to manage dryland in Indonesia.

Discussion

From the literature study, the researchers have developed the table below, making it easier to find and identify each agricultural policy.

Rotiklot water dam in Belu District, East Nusa Tenggara.
http://sda.pu.go.id/pusben/

Table 1. Policy identification

No.	Regulations	Output (5 Years)	Outcome (Over 5 Years)
1	Law Number 41 of 2009 concerning Protection of Sustainable Agricultural Land	The availability of irrigated land, reclamation land, non-irrigated land.	Establishment of sustainable agricultural areas, sustainable food, agricultural land, land for sustainable food reserves.
2	Government Regulation Number 01 of 2011 concerning Determination and Transfer of Function of Agricultural and Food Land	Establish sustainable agriculture areas, sustainable food lands, sustainable food reserves.	1. The availability of agricultural land 2. controlling land-use change 3. food security 4. farmers' welfare
3	Government Regulation Number 12 of 2012 concerning Incentives for the Protection of Sustainable Agricultural Land	1. Infrastructure 2. research 3. development of superior seeds 4. information and technology 5. agricultural facilities and infrastructure	1. Building partnerships with stakeholders 2. accelerating the establishment of agricultural food lands 3. legal certainty for farmers
4	Government Regulation Number 25 Year 2012 Concerning Sustainable Agricultural Land Information System	1. Agricultural data inventory, and 2. data management.	Obtain accurate data as a reference for planning and the realisation of integrated land protection.
5	Government Regulation Number 30 of 2012 concerning Financing for the Protection of Sustainable Agricultural Land	1. Financing 2. farmer protection 3. planning	1. Land inventory 2. Land identification 3. Land verification
6	Law Number 16 of 2006 concerning Agricultural, Fisheries and Forestry Extension Systems	Providing agricultural facilities and infrastructure, professional staff.	The building of extension centres in the provinces, districts, sub-districts.
7	Presidential Instruction No. 01 of 2018 concerning the Acceleration of Provision of Small Reservoirs and Other Water Storage Buildings in the Village.	The availability of dams through the allocation of village funds, local budgeting, government, sanctions to the governor, regents who do not provide agricultural facilities.	The development of reservoirs throughout Indonesia.
8	Law Number 19 of 2013 concerning Protection And Farmer Empowerment	Availability of farm roads, dams, reservoirs, agricultural warehouses, subsidies, quality seeds, crop failure guarantees, education.	The realisation of new agricultural land, the fulfillment of national food security.

The purpose of the above policies is to realise national food security, and improve the welfare of farmers. There have been achievements through planning, identification of agricultural land and dryland, infrastructure development such as farm roads, construction of dams, construction of irrigation systems and releasing new areas of land, protecting the legal certainty of land ownership, building agricultural extension centres at provincial, district, sub-district levels related to improving the ability of government farmers to provide education and empowerment, establishing infrastructure development and overcoming water unavailability. From some of the explanations above, the Government does not yet have a policy related to the management of dryland specifically.

Future work

Based on the results of this library research, the Government does not have a policy related to the management of dryland, and the researchers recommend that the Government issue a policy on how dryland should be managed. There is social impact arising from this unmanaged dryland, because the community there does not have income for the family, yet the community requires funds for survival, to cover the costs of their daily needs, children's education, family health and traditional ceremonies. For future work, the researchers are very interested to examine how people on dryland survive and meet other needs.

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Government Regulation Number 30 of 2012 concerning Financing for the Protection of Sustainable Agricultural Land.

Presidential Instruction No. 01 of 2018 concerning the Acceleration of Provision of Small Reservoirs and Other Water Storage Buildings in the Village.

Jatigede Dam. http://sda.pu.go.id/pusben/

3. WATER SUPPLY INVESTMENT ANALYSIS FOR MAIZE FARMING DEVELOPMENT IN DRYLAND: A case study of Oeteta Village, Sulamu District, Kupang Regency

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Abstract

Nusa Tenggara region has large expanses of dryland that have potential to be developed. The availability of water is one of the factors affecting efforts to use dryland, and it plays a role in helping to increase land productivity. There are technically feasible potential opportunities for using groundwater for irrigation in dryland in East Nusa Tenggara. This study has been carried out in Oeteta Village, Sulamu District, Kupang Regency in April–September 2019; it involved two farmer groups and 45 cooperative farmers. The objective of this study was to determine how much capital investment is needed for managing maize cultivation in the dry season using piping and water-pumps. The results showed that (1) an effective water supply regime during one planting period in the dry season is to irrigate 7 times at intervals of 7–8 days; (2) the length of pipe needed in the production process is one that will water 80–100 maize stems, depending on the distance to the pump or water source; (3) the irrigation cost is around Rp 300,000 – Rp 500,000 per hectare per planting period; (4) this watering regime produced 7.8–8.5 tons/ha; (5) the Net Benefit Cost Ratio B/C is 3.45 and Gross Benefit Cost Ratio (Gross B/C)) is up to 2.87, which means that the investment should be successful.

Keywords: investment analysis, water, maize, dryland

Abstrak

Wilayah Nusa Tenggara memiliki hamparan lahan kering yang luas dan berpotensi untuk dikembangkan. Ketersediaan air sebagai salah satu penentu dalam upaya pemanfaatan lahan kering, berperan dalam membantu meningkat kanproduktivitas lahan. Potensi dan peluang pemanfaatan air tanah untuk irigasi lahan kering di Nusa Tenggara Timur secara teknis memungkinkan untuk diterapkan. Kajian ini telah dilaksanakan di Desa Oeteta Kecamatan Sulamu, Kabupaten Kupang pada bulan April – September 2019, yang melibatkan 2 kelompok tani dan 45 orang petani kooperator. Tujuan penelitian ini adalah untuk mengetahui berapa besar investasi yang diperlukan dalam pengeloloaan usahatani jagung di musim kemarau dengan menyertakan modal berupa pipa paralon dan mesin pompa air. Hasil penelitian menunjukkan bahwa (1) pemberian air yang efektif selama satu periode tanam di musim kemarau adalah 7 kali penyiraman dengan selang waktu penyiraman antara 7 – 8 hari sekali, (2), Paralon yang diperlukan dalam proses produksi berkisar antara 80 – 100 batang tergantung jarak antara lahan dan sumber air yang tersedia, (3) Biaya penyiraman yang diperlukan berkisar antara Rp 300.000 sampai Rp 500.000/ha/sekali siram, (4) Produktivitas yang dihasilkan 7,8 – 8,5 ton/ha, (5) Nilai Net Benefit Cost Ratio B/C sebesar 3,45 dan nilai Gros Benefit Cost Ratio (Gross B/C) sebsesar 2,87 artinya bahwa investasi dinyatakan layak (feasible) (6) Payback periode terjadi pada tahun ke 1, lebih pendek dari umur ekonomis.

Kata kunci: analisis investasi, air, jagung, lahan kering

Introduction

East Nusa Tenggara is an area categorised as dryland with a dry climate. This NTT dryland has potential because it covers an area of 3.35 Mha and only 34% is managed by the community (Kartiwa et al. 2009). Uncertain rainfall distribution is a dominant factor affecting dryland productivity; therefore special efforts are needed in regulating irrigation water. The provision of irrigation in the tropics often benefits crop production.

NTT = Nusa Tenggara Timur, also known as East Nusa Tenggara.

The results of a water balance analysis (Kedang & Haruna 2008) stated that water surplus in the NTT region occurred in February–April, while water deficit occurred in May–November. Thus, water is a rarity for the people of NTT. Dryland farming practices can be improved by increasing the cropping index from 200 to 300%, where the average for the region is taken as 100 (Sutono et al. 2001; Soelaeman et al. 2001). Corn is a commodity suitable for being grown in dryland because it is efficient in water use and is also resistant to high temperatures.

Fertiliser and sufficient water for plant growth are two major factors supporting maximum corn productivity. Where corn cultivation is dependent on rain water, delay at planting time will lead to water stresses later in the growth phase, at seed set. Therefore it is very important to irrigate corn plants, providing water at optimal timing and quantities and targeting. Such efficiency can increase productivity and enable increased planting areas and crop intensity.

Maize farming in dryland generally utilises groundwater through paralon pipe (Paralon PVC pipe) technology, in the same way as in paddy fields. However, the irrigation technology adopted by maize farmers is not supported by the institutions that regulate irrigation management, nor by accessibility of financing; there is an absence of clear government policies for the development and management of irrigation systems for corn. Farmers strive independently for the sustainability of their irrigation facilities, setting aside money from their farming income to pay for fuel and maintenance.

The problem faced in Oeteta Village is that the existing corn irrigation system has not been able to support an increase in corn production. Increased production is one indicator to measure the success of irrigation system development as a management process in irrigated agriculture subsystems.

Approach

This research was conducted in April–September 2019, in Oeteta Village, Sulamu District, Kupang Regency, involving 2 farmer groups and 45 cooperative farmers.

This research model takes the form of assistance to a target group. It included the making of 7 ha Maize Farm Demonstration Plots, and technical assistance with cultivation, and access to capital resources.

Discussion

An effective watering regime during one planting period in the dry season is 7 irrigations at 7–8 day intervals. The watering can be timed according to the period of plant growth for maximum water use efficiency.

The length of Paralon pipe required in the production process of maize should be sufficient to water 80 to 100 stems depending on the distance between the crop and the available water source, and the pipe purchased by this capital investment can be used for approximately 5 years before it becomes too damaged for use.

Watering costs ranged from Rp 300,000 to Rp 500,000/ha/one-flush. Costs were also incurred for fuel and labour.

The resulting yields were 7.8–8.5 tons/ha, showing that by investing in pipes, corn farming can still produce maximum yields in the dry season.

The Net Benefit–Cost Ratio was 3.45, and the Gross Benefit–Cost Ratio was 2.87, which meant that the investment can be declared feasible.

Future work

This investment analysis model is one way to plan the development of irrigation systems in corn farming in dryland. Analysis of the aspects of the irrigation system can also be applied to the development of other commodity irrigation systems in the dry season.

A PVC pipeline crossing a cornfield.

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4. WATER SUPPLY THROUGH AIR VACUUM TECHNOLOGY & TAMREN IRRIGATION SYSTEM IN DRYLAND FOR SUPPORTING A HORTICULTURE FARMING SYSTEM

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Abstract

Assuring water supply is a crucial factor in managing biosecurity and biodiversity. Maximising use of rainfall is a key factor in this. Annual rainfall can be stored as much as possible in reservoirs in the rainy season and can be used for agricultural development. This research, on dryland in a time of climate change, explores how to maximise the availability of water collected during the rainy season in a reservoir using air vacuum technology and Tamren irrigation systems. The research was conducted in Sokon-Fatukoa Village, using farming system research methods, and the resulting production was 8701 kg of tomato variety Ratna, 748 kg of big chilli variety Lembang 1 and 450 kg of onion variety Bima, with a total farmers' revenue of Rp 41,846,000/ha and farmers' income of Rp 19,576,000/ha.

Keywords: rainfall, irrigation systems, dryland, incomes

Abstrak

Memastikan penyediaan air adalah faktor penting dalam mengelola keamanan hayati (biosekuriti) dan keanekaragaman hayati (Biodiversity). Memaksimalkan penggunaan curah hujan adalah faktor utama dalam hal activitas ini. Curah hujan tahunan dapat disimpan sebanyak mungkin dibendung sepanjang musim hujan dan dapat digunakan untuk pengembangan pertanian. Penelitian ini dilaksanakan pada lahan kering dalam kondisi perubahan iklim dengan memaksimalkan ketersediaan air yang ditampung selama musim hujan di waduk dengan menggunakan teknologi vakum udara dan sistem irigasi Tamren. Penelitian ini dilakukan di Sokon, Desa Fatukoa. Penelitian ini menggunakan metode penelitian sistem pertanian. Hasil penelitian menunjukkan bahwa produksi Tomat mencapai 8.701 kg Tomat varietas Ratna, 748 kg cabai varietas Lembang 1 dan 450 kg bawang merah varietas Bima dengan total penerimaan petani mencapai Rp 41.846.000/ha dan pendapatan petani mencapai Rp 19.567.000/ha.

Kata kunci: curah hujan, sistem irigasi, lahan kering, penghasilan

Introduction

Potential runoff in Nusa Tenggara Timur (NTT) is adequate to sustain production even though there are only 3–4 months of rain annually (Kedang et al. 2010) and annual rainfall of up to 1413 mm (in 2015) or 1406 mm (in 2016) according to rainfall records (Anon. 2015, 2016). During the rainy season there often are strong winds and sometimes heavy rain, followed by a dry period of up to two weeks (Apriyana et al. 2010). However, where this annual rainfall has not been stored in a reservoir, it flows away towards the sea.

The availability of water is a limiting factor for agricultural production in dryland, meaning that water is essential in the management of dryland agricultural systems. The Dryland region in NTT has an 8–9 month dry season, when there is usually no rain and water is scarce.

The potential dryland area for agricultural food crops in Bali and Nusa Tenggara is 645,891 ha (Irsalas & Ani Muliani 2015). In this region there is plenty of available land, with full sunlight offering perfect photosynthetic opportunities, with moderate to high levels of phosphate and low levels of nitrogen (Dariah et al. 2014).

In dryland with limited water, farmers use ‘shifting farming cultivation’. The main technique is ‘slash and burn’. The main crop is corn as a staple food, with various local beans and local cassava, all of which are planted in the rainy season and with minimal inputs.

The Government in NTT Province has built several dams to capture water for household consumption, and for agriculture and animal husbandry. One of the dams was built in the Sokon-Fatukoa Village, with an irrigation system to support agriculture in the dryland in a time of climate change (Haryono 2013). The technology in use is very simple and allows watering for farming during the dry season.

One of the farming systems that can be developed in the dry season is horticulture, growing tomato, chili and onion crops. Using irrigation enables farmers to practise productive agriculture for the whole dry season.

Approach

This research was conducted in Sokon-Fatukoa Village, Wali kota District, NTT. The location was chosen based on these criteria: (1) the location must have access to dam water, (2) there is already farming established there, (3) farmers are available to apply the technology in this research.

The research uses the current farming systems, with these criteria: (1) the research is to be done in farmers' fields, (2) the farmer is involved in conducting the research, and (3) the researcher, extension worker and technician are always available to assist the farmer (Sumarno 1997).

The researchers applied these technologies: vacuum air technology; the Tamren irrigation system; application of organic matter during the farming; and best-practice cultivation to suit the type of horticultural crop – that is, tomatoes, chilis and onions.

Vacuum air technology: the rainfall throughout the rainy season is stored in the reservoir at one topographic level and can be moved to a higher level for use in farming. The water in the reservoir is pumped to bottom of the hill through plastic pipe and then the water pressure pushes the water uphill to the higher levels where it is needed for farming. After ten minutes of pumping, the pump is turned off and water pressure maintains the water flow for the irrigation in the farming area.

Tamren irrigation system technology: water is stored in small storage reservoirs ready to be used on the farm. From these it is easy to use the water to irrigate each horticultural bed efficiently, while the farmer can be doing other tasks.

Organic matter application: the organic matter consists of manure and biochar. These two are mixed equally and then applied to each planting hole.

The best practice cultivation is as follows:

1. Land preparation. Plough the field by hand with a rotary tractor; then make beds 1 m x 25 m.
2. Apply the organic matter and biochar to enrich the soil.
3. Make seedbeds suited to big chili and tomato and onion.
4. Seed treatment special to onion: cut the tip of the onion bulbs and apply fungicides to prevent fungal attack. Treatment of onion bulbs with fungicides is one strategy for preventing disease attacks on onion (Dianawati & Kusyaeri 2017).
5. Use the correct plant spacing for tomato, big chili and onion.
6. Apply the watering technology to maintain soil moisture.
7. Apply pest and disease control at each stage of growth.

Discussion

Water was supplied whenever irrigation was needed, through the vacuum air technology and the Tamren irrigation system. The farming systems were tested across one hectare, growing tomatoes on 0.5 ha, big chili on 0.3 ha and onions on 0.2 ha. The total cost of the farming was Rp 22,270,000/ha, consisting of fixed costs of up to Rp 13,880,000/ha and variable costs of up to Rp 8,390,000/ha.

The resulting production was 8701 kg tomatoes, 748 kg of big chili, and 450 kg of onions with a total farmers' revenue of Rp 41,846,000/ha and farmers' income of Rp 19,576,000/ha.

The recommendation from this research is to scale up to larger scale production in the dryland in this time of climate change.

Future work

This technology has the potential to be developed in dryland areas to increase land productivity and profitability of farmers. There needs to be a development strategy. Implementation in the field will involve collaboration with other stakeholders such as extension workers, officers of the agriculture department, bank officers and traders.

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5. IDENTIFICATION OF DROUGHT TOLERANCE IN SOYBEAN CULTIVARS USING A STRESS SUSCEPTIBILITY INDEX

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Abstract

Drought stress is a major limiting factor to the growth and yield stability of soybean. To identify drought-tolerant soybean cultivars, an experiment was conducted in the research field of Gadjah Mada University. The research was arranged in a randomised complete block design with two factors. The first factor was soybean cultivar, namely Wilis, Tidar, Gema, Grobogan and Argomulyo. The second factor was watering interval: plants were watered every day to simulate optimal conditions, or watered every 8 days as a form of drought stress treatment. From the results, Wilis and Tidar were selected as cultivars with better drought tolerance than the others, having a moderate stress susceptibility index.

Keywords: drought stress, stress susceptibility index, grain yield, soybean, cultivar

Abstrak

Cekaman kekeringan merupakan faktor pembatas utama bagi pertumbuhan dan hasil kedelai. Untuk mengidentifikasi kultivar kedelai yang toleran terhadap kekeringan, sebuah penelitian telah dilakukan di Kebun Percobaan Universitas Gadjah Mada. Penelitian ini dirancang menggunakan rancangan acak kelompok lengkap dengan dua faktor. Faktor pertama adalah kultivar kedelai yang terdiri atas : Wilis, Tidar, Gema, Grobogan dan Argomulyo. Faktor kedua adalah interval penyiraman dimana tanaman diisiram setiap hari untuk menilai kondisi optimal dan disiram 8 hari sekali sebagai bentuk perlakuan cekaman kekeringan. Hasil penelitian menunjukkan Wilis dan Tidar dipilih sebagai kultivar yang memiliki tingkat ketahanan terhadap cekaman kekeringan lebih baik dibandingkan kultivar lainnya karena memiliki indeks sensitiviitas cekaman pada level moderat

Kata kunci: cekaman kekeringan, indeks sensitivitas cekaman, hasil biji, kedelai, kultivar

Introduction

Drought stress in plants generally occurs in conditions where the availability of water in the soil decreases and the rate of water loss is relatively high because of transpiration and evaporation processes (Jaleel et al. 2009). Drought conditions that occur either temporarily or continuously can cause physiological and biochemical changes in plants, which will ultimately affect the growth and development of plants and lead to a decline in economic output.

Legumes are very sensitive to drought, in both the vegetative and the reproductive phases. Soybean is an important legume that is susceptible to drought, especially during flowering and pod-filling. Drought stress that occurs during flowering results in an increase in the number of flowers and fewer young pods. If the drought continues into the period of forming and filling pods and seeds, it will result in reduced yields because of the reduced number and weight of pods per plant (Suyamto 2004). Selecting cultivars for drought tolerance is an important step in maintaining and improving soybean productivity.

Previous studies have reported that stress susceptibility index (SSI) is one of the indices that can be used for identifying drought tolerance in various crops (Fischer & Maurer 1978, Ali & El-Sadek 2016, Widyastuti et al. 2016). Soybean cultivars were assessed for their SSI by calculations based on grain yield under various conditions. Evaluating drought tolerance based on grain yield is considered an effective method for determining the combination of drought tolerance and yield potential.

Approach

The research was carried out in the research field of Gadjah Mada University. This study used a randomised complete block design in testing five cultivars: namely, Wilis, Tidar, Gema, Grobogan and Argomulyo, planted in a 40 x 40 cm polybag. All cultivars received the same watering regime until 24 days after planting. After that, the plants in the 'unstressed' treatment were watered up to field capacity every day, while plants in the 'drought stressed' treatment were watered every 8th day. Grain yields under stressed and non-stressed conditions were calculated to determine the effect of drought stress on crop yields.

To evaluate the drought tolerance of these cultivars their stress susceptibility indexes (SSI) were determined using the SSI method of Fischer & Maurer (1978):

$$SSI = (1 - (Y_S / Y_P)) / (1 - (Y_{\bar{S}}/Y_{\bar{P}})),$$

where Y_S, Y_P, $Y_{\bar{S}}$, $Y_{\bar{P}}$ represent, respectively, yield under stressed condition, yield under non-stressed condition for each cultivar, and mean yield under stressed and non-stressed conditions for all cultivars.

The levels of drought-stress tolerance were determined based on SSI values: a cultivar is tolerant if SSI ≤ 0.5, moderately tolerant if 0.5 < SSI ≤ 1.0 and drought-sensitive if SSI > 1.0 (Widyastuti et al. 2016).

Discussion

Stress susceptibility index, SSI, is one index that can be used to assess the effects on yield of a sub-optimum compared to optimum environment (Fischer & Maurer 1978). Analysis of drought stress tolerance based on SSI showed that Wilis (0.77) and Tidar (0.84) had stress indexes at moderate levels. Ali & El-Sadek (2016) stated that a stress index at moderate level can be used to determine drought tolerant wheat genotypes. Therefore, despite showing moderate levels of stress susceptibility, Wilis and Tidar can be classified as tolerant cultivars; they had smaller SSI than the other cultivars (see Table 1).

Table 1. Soybean cultivars stress susceptibility index under drought condition

Cultivars	Condition		Stress susceptibility index	
	Non-stress condition (optimum)	Stress condition (sub-optimum)		
Wilis	7.63	4.18	0.77	(Moderate)
Tidar	6.99	3.53	0.84	(Moderate)
Gema	6.99	2.89	1.00	(Sensitive)
Grobogan	6.70	1.99	1.20	(Sensitive)
Argomulyo	6.80	1.95	1.22	(sensitive)

Plant resistance is the capacity of plants to produce a yield in an unfavourable environment (Taiz & Zeiger 1998). Wilis had a higher seed dry weight than Grobogan and Argomulyo although both cultivars belong to a 'large seed' group of soybean cultivars. Dry weight of seeds per plant was more directly affected by the number of seeds per plant than by seed size.

Drought stress reduces the number of filling pods and number of seeds per plant, and that led to reduced soybean yield from the soybean cultivars that had 'sensitive' SSI. Soybean seed dry weight depends on availability and distribution of photosynthate, especially during the seed-filling period (Mapegau 2006). Under drought stress the amount and distribution of photosynthate into the seeds is reduced, therefore decreasing the seed dry weight.

Based on the results, Wilis and Tidar can be used for cultivation in dryland areas because their yields should be less reduced in conditions of water stress.

Future work

Future plant breeding programs should focus more on the use of germplasm from local sources which have had their characteristics tested to identify superior traits. By utilising local material, it is expected that the modern varieties produced will have a wide genetic diversity, but still have the adaptability of specific agroecosystems. Therefore there is a need for inventory and selection of existing local plants, in order to obtain local plants that have the potential to be cultivated and adapt well to local agroclimatic conditions.

In addition, the imperative to maintain agricultural biodiversity can also be a basis on which policy makers and scientists can determine appropriate climate change adaptation measures based on local biodiversity resources. As a step to support the program, as well as to keep local germplasm from extinction, we hope to cooperate with farmers in Indonesia to take part in collecting local germplasm in their respective regions. We also hope to work together with the UGM Center for Innovation and Agrotechnology through the national vegetable genetic bank to be able to centralise and centrally conserve local germplasm collected by farmers. So if one day farmers, researchers and other people want to do a breeding program they can access the local Indonesian germplasm with good information about its characteristics.

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6. UTILISATION OF ORGANIC POTS WITH SAND AS MEDIA FOR GROWING SEMIN SENGON

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Abstract

Utilisation of organic pots as a medium for growing plants in sand and nutrient-poor soils, in relation to the ability to store water, is expected to be a solution for drought conditions in the city of Kupang. The growth of sengon seedlings in organic pots (of chicken or cow manure or litter), with sandy soil (ex-Merapi eruption) and nutrient-poor soils, was compared using a completely randomised design and Duncan's Multiple Range Test at a significance level of 5%. The results showed that organic pots with sandy soil notably increased water requirements, which affected the growth and height of sengon seedlings. However, in nutrient-poor soils, the treatment of organic pots did not affect the plants' water needs.

Keywords: sand soil, nutrient-poor soil, organic matter, sengon seedlings

Abstrak

Pemanfaatan pot organik sebagai media tumbuh tanah pasir dan tanah miskin hara kaitannya dengan kemampuan menyimpan air diharapkan menjadi solusi bagi kondisi kekeringan di kota Kupang. Pemanfaatan pot organik (ayam, sapi, seresah) untuk pertumbuhan semai sengon pada tanah pasir (bekas erupsi merapi) dan tanah miskin hara dianalisis CRD (Complete Randomized Design) dan DMRT (Duncan Multiple Range Test) tingkat signifikan 5%. Hasil menunjukkan bahwa pot organik tanah pasir meningkatkan kebutuhan air secara signifikan sehingga berdampak pada pertumbuhan tinggi semai sengon. Sedangkan pada tanah miskin hara, perlakuan pot organik belum memberikan pengaruh terhadap kebutuhan air.

Kata kunci: tanah pasir, tanah miskin hara, pot organik, bahan organik, semai sengon

Introduction

Sandy soil is not very suitable for plant growth because it has little capacity to hold water and nutrients, so that the plants generally experience nutrient stress and lack of water. The open soil structure has an unfavourable effect, accelerating soil drying and oxidation of organic matter (Kohnke 1968). Addition of nutrients through applying fertiliser on the ground is inefficient because sand has little capacity to bind nutrients which are therefore often lost through leaching.

Land is the most important factor in the process of agricultural production, where the balance of nutrients in it greatly determines the shape and character of a plant. The balance between soil, organic matter content and nutrient content affects the continuation of agriculture in the future.

Lack of soil fertility causes disruption in plant-production processes. Therefore we need to find ways to improve the fertility of the land.

Provision of organic material (for example manure and litter) in pot form is a way to improve soil quality. Organic matter can improve the quality of the soil when it is mixed in well. Organic matter ameliorates soil material by improving physical, chemical and biological soil properties. One of the physical properties of soil that can be improved is its water-holding capacity, because organic matter has a high capacity to preserve soil moisture, so the moisture is less easily lost from the soil, either through vertical flow or horizontal flow. Organic matter also increases aggregate stability in soil directly or indirectly. The formation of aggregates causes the surface runoff to decrease and the infiltration capacity can be maintained for a long time, so that the capacity of the soil to maintain the amount of available water can be increased (Yulianingsih 2004).

The organic pots.

The pots with sengon plants.

Another way to overcome problems in soil is by planting crops. Albizia, *Paraserianthes falcataria* (L.) Nielsen, locally known as sengon, is one of the most important pioneer multipurpose tree species in Indonesia. It is one of the species preferred for industrial forest plantations as it is easily cultivated, has very fast growth, and is adaptable to a variety of soils.

Approach

This study was a pot experiment with a completely randomised factorial design, and each treatment was repeated 3 times (Gomez & Gomez 1995).

The organic matter treatments were:

P1 = pot made from organic matter from chicken manure

P2 = pot made from organic material from cow dung

P3 = pot made from organic materials from litter.

The 3 treatments were each repeated 3 times, giving 9-unit experiments.

This pot experiment was carried out with sandy soils and nutrient-poor soils, each with the same treatments.

Observations and discussion

A. *Sand soil (3 months observation age), as in Pellondo'u (2014)*

a. Water needs at field capacity

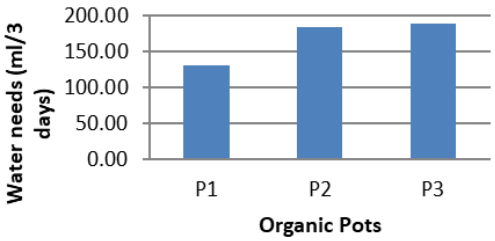

Figure 1. Water requirements at field capacity in sand soil media

The chart (Figure 1) shows that pots made from organic matter had an influence on the ability to store water, through water requirements in field capacity conditions.

With an average water use of 133.17 mL in pots made from organic matter, the chicken manure gave the highest growth rate at the height of sengon seedlings which is 9.36 cm (Figure 2), but the diameter of the sengon seedlings did not show any notable difference.

b. Seedling height

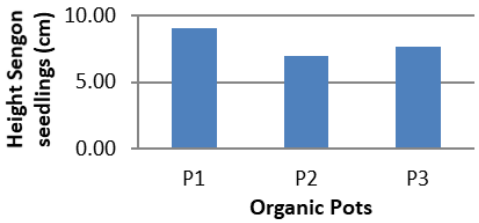

Figure 2. Height of sengon seedlings growing in sand soil

The results of the variety analysis showed that pots made from organic matter did not have a notable effect on the height of the sengon plant at the age of 3 months.

c. Seedling diameter

The results of the variety analysis showed that pots made from organic matter did not have a notable effect on the diameter of the sengon plants at the age of 3 months (Figure 3).

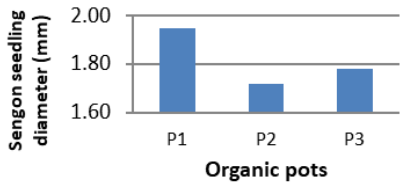

Figure 3. Diameter of sengon seedlings growing in sand soil

B. *Nutrient-poor soil (observations at 3 months age)*

a. Water demand at field capacity

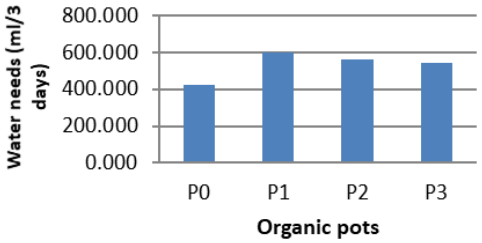

Figure 4. Water demand at field capacity in nutrient-poor soil

b. Seedling height

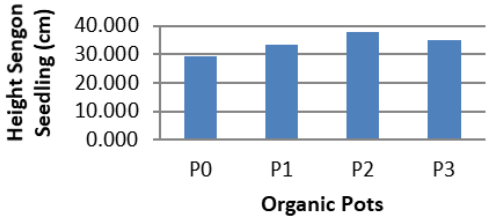

Figure 5. Sengon seedling height in the nutrient-poor soil

c. Seedling diameter

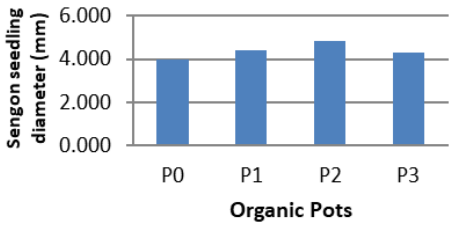

Figure 6. Diameter of sengon seedlings in nutrient-poor soil

Based on the charts above and three months of observation, it can be seen that the use of organic material has not had a notable influence on water demand when the soil is at field capacity.

The control treatment (P0) showed a decrease in water demand (Figure 4), presumably because pots without organic matter gave high growth and low stem diameters so that they made less use of existing water during the transpiration process.

The use of organic pots made from cow manure began to show an increase in water use efficiency, as can be seen from a chart that began to decline, supported by the growth of seedlings that are increasingly tall (an increase in water use efficiency).

From these two studies we have found very useful information related to increasing the efficiency of water use by using organic-based pots that can be applied as growing media in urban forest parks where Albizia (sengon) can play a valuable role.

Future work

We are facing climate change that continues to increase and result in high temperatures, leading to greater demand for water which then lowers groundwater supply, especially in the city of Kupang with low rainfall. Pots made from organic materials will be tested with low-nutrient dry soils, with the aim of being able to store water as much as possible during the rainy season while increasing nutrient content in the soil.

In the future, further research will aim to obtain pots made from organic material that are stronger and more durable so that they can be used for a longer time, as are pots made of clay.

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COMMUNITY ROLES IN MANAGING BIODIVERSITY AND BIOSECURITY IN A TIME OF CLIMATE CHANGE

7. ***Agus Saputra***
   Food diversification to suppport food security based on local resources due to climate change: case study of avocado fruit in TTS District

8. ***Pantoro Tri Kuswardono Kuswardono***
   Studying the political ecology of a social-ecological system of retention basins in a small island

9. ***Titi Susilowati Prabawa***
   Promoting local food through tourism development: a case study in Nemberala Village, Rote Island, East Nusa Tenggara

10. ***Ester Elisabeth Umbu Tara & Sherly Lapuimakuni***
    Why they want to farm: a socio-economic environmental study of why rural young women choose to become farmers

11. ***Linda Susilowati***
    The roles of women in dryland and other production systems: an overview

12. ***Ferly Tanggu Hana***
    The contribution of women's communication in the family towards biodiversity and biosecurity issues

13. ***Natalia Bita Bisik***
    Community-based climate change adaptation in managing biodiversity and biosecurity

14. ***Made Santiari***
    Plants as indicators of pollution

7. FOOD DIVERSIFICATION TO SUPPORT FOOD SECURITY BASED ON LOCAL RESOURCES DUE TO CLIMATE CHANGE: CASE STUDY OF AVOCADO FRUIT IN TTS DISTRICT

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Abstract

Food diversification is a strategy to increase added value and support food security. Food security is a challenge amid the current climate change. Increasing droughts are reducing agricultural yields, and require the right solutions. In South Central Timor district, avocado production on the east coast has not yet reached its full potential. The economic value of avocados is still low and does not receive serious attention. Knowledge and awareness in the community need to be increased, via various activities such as training, including workshops. The proposed training aims to introduce processing technologies that add to the value of the fruit. To achieve this, collaboration must be intensified with various groups such as researchers, entrepreneurs and the government.

Keywords: food diversification, food security, avocado, climate change

Abstrak

Diversifikasi pangan adalah strategi untuk meningkatkan nilai tambah dan mensupport keamanan pangan. Keamanan pangan menjadi tantangan ditengah perubahan iklim saat ini. Kekeringan yang semakin panjang sehingga hasil pertanian berkurang membutuhkan solusi yang tepat. Kabupaten Timor Tengah Selatan sebagai penghasil buah alpukat di pulau timor, belum mengolahnya dengan maksimal. Nilai ekonomi alpukat masih rendah dan tidak mendapat perhatian serius. Pengetahuan dan kesadaran masyarakat perlu ditingkatkan dengan berbagai kegiatan seperti pelatihan atau lokakarya. Pelatihan ditujukan untuk pengenalan berbagai teknologi pengolahan yang menambah nilai tambah buah. Untuk itu kolaborasi harus diintensifkan dengan berbagai pihak seperti peneliti, pengusaha, dan pemerintah.

Kata kunci: diversifikasi pangan, ketahanan pangan, alpukat, perubahan iklim

Introduction

Biosecurity, food security, and climate change are complex issues that are closely interrelated. If climate change leads to longer dry seasons, that will have an impact on agricultural output. This can disrupt food security and also affect biodiversity. For this reason, a problem-solving approach is needed.

The South Central Timor district (TTS) is a mountainous region with a cool climate compared with coastal areas where average temperatures are around 25^{o}–35^{o}C. It is located about 110 km from the town of Kupang. With its suitable geographic conditions and fertile land, TTS is a producer of various types of agricultural products. Most of the agricultural products, including avocados, are distributed to other regions in Kupang. Normally, many avocado plants grow in TTS though they are not specifically cultivated. The quality of the fruit produced is good, but it is a seasonal fruit that is available only during January to April. However, good processing management can extend the period of availability of the product.

Currently avocados are only used for their flesh. Seeds and skins are just waste. Various studies show that many avocado seeds contain metabolites both primary and secondary. Primary metabolites include carbohydrates (23% starch), fat and protein, while secondary metabolites include polyphenols, flavonoids, triterpenoids, quinones, saponins, tannins, monoterpenoids and sesquiterpenoids. These metabolites have been used in health fields such as in the treatment of kidneys (kidney stones), and as antioxidants, antibacterials and anti-cancer drugs.

To support food security, the effectiveness of utilisation of avocados should be increased, including the use of parts that are currently considered waste.

Fresh avocados in the traditional market.

Approach

Avocado plants in South Central Timor Regency grow throughout the region. For this project, the first step will be to map the avocado production in each area. The mapping results can then be used as a basis for grouping regions. Areas that have high avocado productivity will be used as work target areas.

Local communities will then be offered information about processing techniques that increase the value of the fruit. The technology can be shared through training.

The community will be taught how to choose avocados, then separate their flesh, seeds and skin. The flesh can be cut into smaller pieces, then vacuum-packed and stored in refrigeration. The seeds and fruit skins are subsequently converted into powder and packaged.

The next stage will be collaboration with entrepreneurs and local government to help with marketing.

Discussion

Avocados are seasonal fruits that are only available in certain months. When fruit is plentiful, the price falls and many avocados are not eaten, or are damaged. This causes a decrease in the economic value of the fruit. In the traditional markets in Kupang, the price of fruit is observed to be Rp 5000 per kg. Field studies, in the form of interviews with plant owners, find that they are paid relatively lower prices, at Rp 3000 per kg of fruit. By comparison, in Java for the same variety the price is Rp 35,000 per kg.

Diversification and optimisation are strategies that can be used to increase the crop value. Avocados will be separated into three parts. The flesh will be packaged in small pieces and vacuum-packed, while the seeds and skin are packaged in the form of powder.

In this way, from 1 kg of avocado can be obtained about 500 g of fruit flesh, 300 g of seeds, and 200 g of skins. If the price of 1 kg of fruit flesh is Rp 30,000, 1 kg of seed powder is Rp 10,000, and 1 kg of skin powder is Rp 1000, then 1 kg of avocado fruit will have a value of Rp 18,200. For avocado owners the increase in economic value would be Rp 15,200 per kg if the initial selling price of avocados is Rp 3000.

If each house has 5 avocado trees and each tree produces 100 kg, then there will be 500 kg of fruit. From this, the owner will get an income of about Rp 9 million. This value is very large compared to the income if the fruit is sold directly: 500 kg x Rp 3000 = Rp 1,500,000.

Besides increasing economic value, processing will also help preserve the food for a longer time, improving food security.

Future work

In the future, many products may be obtained from avocados, including foods, tea and sunscreen, by collaborating with various stakeholders. Researchers in fields such as food technology, pharmaceuticals, biochemistry and others may identify various potential new products, from avocado alone or mixed with other ingredients. Packaging must also be considered, with attractive packaging designs making consumers interested in buying. Approaches will be made to the government, to support this initiative in terms of regulation and funding, so that the community will get more benefits.

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8. STUDYING THE POLITICAL ECOLOGY OF A SOCIAL–ECOLOGICAL SYSTEM OF RETENTION BASINS IN A SMALL ISLAND

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Abstract

Freshwater supply is a fundamental issue in small islands which have very small catchment areas and a low capacity for water retention. To ensure the availability of water for domestic and agriculture purposes, the Government of Indonesia (GoI) has built hundreds of retention basins in all islands in East Nusa Tenggara Province since 1985 until recent times. In the small island of Semau where this study was undertaken, the availability of more than 24 retention basins did not solve the freshwater problem. Inequality of distribution and usage of water from retention basins has been a latent issue for more than 20 years.

Under the water-provision program of GoI, the management of all small retention basins was handed over to the local community, with the expectation that they would become a common pool resource (CPR) of that community. However, retention basins as CPR is not happening. Using the Social Ecological System Framework (SESF), this study found that one of the governance components of SESF, property-rights, is problematic in achieving CPR. Informants from 5 villages were interviewed and involved in focus-group discussions; they consistently mentioned the word landlord in stories of water conflict, sabotage and exclusion of access to water.

This paper is a short commentary from my study on the political ecology of retention basins in a small island.

Keywords: tenurial, political-ecology, common-pool, social-ecological system, commons, small islands

Abstrak

Ketersediaan air bersih merupakan isu mendasar di pulau-pulau kecil karena wilayah tangkap yang kecil dan kemampuan yang rendah untuk menahan air. Untuk menjamin ketersediaan air rumah tangga dan pertanian, Pemerintah Indonesia telah membangun ratusan embung di semua pulau di Provinsi Nusa Tenggara Timur sejak tahun 1985 hingga sekarang. Di P. Semau, di mana studi ini dilakukan, keberadaan 24 buah embung tidak menjawab persoalan air tawar. Ketidakmeraaan distribusi dan penggunaan air embung adalah isu yang laten selama lebih dari 20 tahun.

Dalam Program Pemerintah Indonesia berkaitan dengan penyediaan air, pengelolaan embung kecil diserahkan kepada masyarakat lokal, dengan harapan embung tersebut dapat menjadi sumber daya milik bersama (common pool resources). Namun, embung sebagai sumber daya milik bersama tidak selamanya terjadi. Dengan menggunakan Kerangka Sistem Sosial Ekologi (Social-Ecological System Framework), studi ini menemukan bahwa salah satu komponen SESF, yaitu penguasaan tanah, adalah salah satu isu yang problematik dalam mewujudkan sumber daya milik bersama. Narasumber dari 5 desa yang diwawancarai dan terlibat dalam diskusi fokus secara konsisten menyebutkan secara konsisten kata-kata tuan tanah dalam cerita sengketa air, sabotase dan juga eksklusi terhadap akses atas air.

Artikel ini mereupakan komentar pendek dari studi penulis tentang ekologi-politik embung di buah pulau kecil.

Kata kunci: tenurial, ekologi-politik, common-pool, sistem sosial-ekologi, commons, pulau kecil

Introduction

The importance of studying small islands is not merely because of their vulnerability to climate-change, particularly to sea-level rise (Solomon et al. 2007). Instead, vulnerability to freshwater availability has been recognised since the early 1990s. Small islands cannot depend on a natural

hydrological cycle because of their shape and small catchment areas (Falkland & Custodio 1991). To address the freshwater challenge, water catchment infrastructure needs to be built, or an advanced technology such as seawater desalination needs to be installed to provide freshwater for the island dwellers (Falkland & Custodio 1991).

Although the development of retention basins was considered a solution to increase freshwater reserves, several studies on the sustainability of retention basins show that they are not effective (Notoatmojo & Rivai 2001; Triastono & Lidjang 2007; Pradhan et al. 2011; Bunganaen 2013). Triastono & Lidjang (2007) and also Bunganaen (2013) have explained that, on average, water volumes in retention basins in Timor were only 40–60% of capacity. Most retention basins studied have a high sedimentation because of lack of management of their catchment areas. Both studies concluded that there is no governance at micro-basin level to prevent sedimentation in each retention basin. On the contrary, government is expecting that a self-governing system can emerge and be established to sustainably manage the basin (Pradhan et al. 2011; Triastono & Lidjang 2007).

As well as technical and institutional problems, conflicts among communities also arise in many retention basins. Ratumakin et al. (2016) mentioned that tensions and conflicts related to water resources occurred in 15 sub-districts in Kupang District. Ratumakin et al. (2016) recorded that tensions and conflicts were among those who have claims on ancestral land (landlords) and commoners. The landlords, usually using customary rights of land, exclude commoners from accessing water in retention basins built for public use. Tensions and conflicts over access to water, particularly from built infrastructure, are likely to become common in East Nusa Tenggara.

This research aims to study, first, the nature of conflicts over retention basins as a social–ecological system (SES); second, the contribution of locally evolving tenurial systems to the conflicts; third, policy as influencing external factors contributing to the evolving tenurial system in the retention basin SES.

Approach and outcomes

Study area

The study is located in Semau Island (Figure 1), which is 26,750 ha in area. Semau Island is a semi-arid island according to Schmidt and Oldeman's climate classification (Types E and F) (Kaho 2019). The population of the island in 2018 was 12,776 inhabitants. Shallots and chili are the main agriculture production. Semau is the largest producer of shallots (BPS Kabupaten Kupang 2019). The small island also has more than 9000 cows (*Bos sundaicus*) owned by the island inhabitants (BPS Kabupaten Kupang 2019). Demand for water for shallots and horticulture and cattle can increase competition for water resources.

Figure 1. Study area.
(Inset map by CartoGIS Services, College of Asia and the Pacific, The Australian National University.)

The study is undertaken in 4 villages where most of the retention basins have been built since 1985. The villages are Hansisi, Uiasa, Huilelot and Batuinan. There are two reasons why the study has been undertaken in these 4 villages. First, the villages represent the age of retention basins. Secondly, the 4 villages are different sub-ethnically, having different kinds of tenurial system.

Conceptual framework

The retention basin is one of the world's oldest infrastructures for harvesting rainwater (Boers et al. 1986). It is also the easiest infrastructure to build in small islands (Falkland & Custodio 1991). Retention basins can also be an indicator regarding the sustainable management of micro-basins because the sustainability of retention basins depends on the health of their water catchment areas (land cover). A high rate of sedimentation in retention basins shows that the upper areas of the basin catchment are disturbed (Kerr 2007; Ali et al. 2010).

A retention basin is basically a socio–ecological system (SES). Berkes & Folke (1998) explain that an SESF (socio-ecological system framework) is an approach used to study multi-level systems of essential services such as food, fibre, energy and water. A social–ecological system framework consists of a resource system component, a resource unit component, a governance component, a user component, and the action situation as the result of the dynamics of other components (McGinnis & Ostrom 2014; Figure 2). An SESF is an approach designed to identify the dynamic critical relation between elements so as to study the socio-ecological system. Research by Triastono & Lidjang (2007), Bunganaen (2013) and Ratumakin et al. (2016) has indicated that the complexity of water resource management is basically a problem of socio-ecological systems.

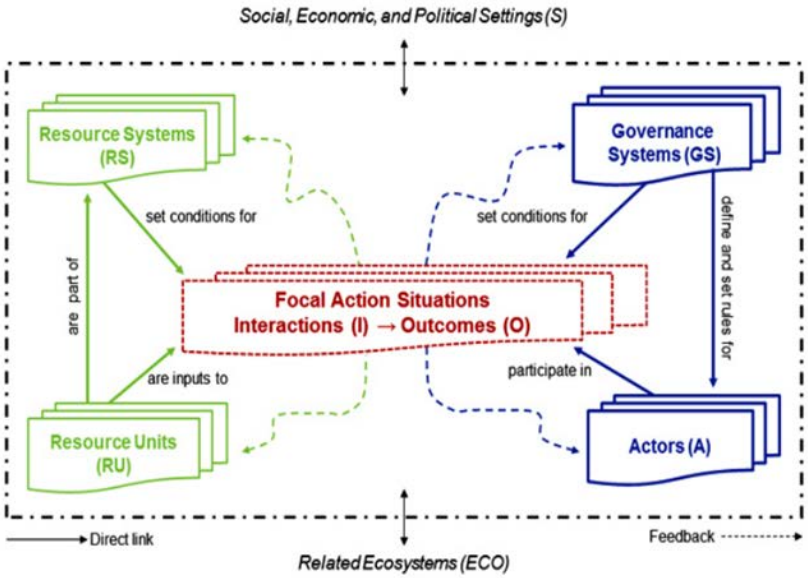

Figure 2. Social–ecological system framework

Methods

This is a mixed methods study, applying conversion mixed data analysis (Teddlie & Tashakkori 2009). The methods quantify qualitative data and then analyse the data with descriptive statistics and network analysis to find the most significant themes raised by resource persons (Teddlie & Tashakkori 2009). A grounded theory approach was also used to construct and interpret the phenomena of governance, actors, and action-situations (conflicts and tensions) in SES (Creswell 1998).

Expected outcomes

The study will explain the influence of the evolving tenurial system and its relation to external factors on the performance of retention basins. By understanding this phenomenon, stakeholders may be encouraged to pay more attention to an institutionalisation process in the development

of community-based infrastructure. Effective institutions are assumed to make resources more sustainable in terms of ecology and economics (Ostrom 1990) especially in small islands where freshwater is fundamentally limited. An effective institution would also address the evolving tenurial systems and property rights issues at local level, which is the central topic of this study.

Discussion

Physically, a retention basin is part of a small hydrological system. It consists of rainwater catchment areas, water collecting areas and infiltration areas, and the downstream where people usually use the water directly from retention basins (Boers & Ben-Asher 1982; Rockström et al. 2004; Vohland & Barry 2009). The retention basin system can also be intended to increase water infiltration so as to raise the groundwater table (Boers & Ben-Asher 1982; Susilowati 2013; Vohland & Barry 2009). The ability of retention basins to catch optimum rainwater depends not only on rainfall rate but also on the condition of the water catchments and runoff areas (Falkenmark & Rockström 2004; Rockström et al. 2004; Vohland & Barry 2009). Degradation of water catchment areas can lead to lower performance of a retention basin in collecting and retaining water. Therefore, management of the retention basin as an ecological system is imperative. An effective social institution within the ecological system of retention basins may sustain the retention basins as SES, which means conserving and rehabilitating the ecosystem at the upper-stream part of the catchments as well as sustainable and equitable use downstream of the system (Kerr 2007). 'Effective institution' here also means that it addresses the evolving tenurial and property rights issues.

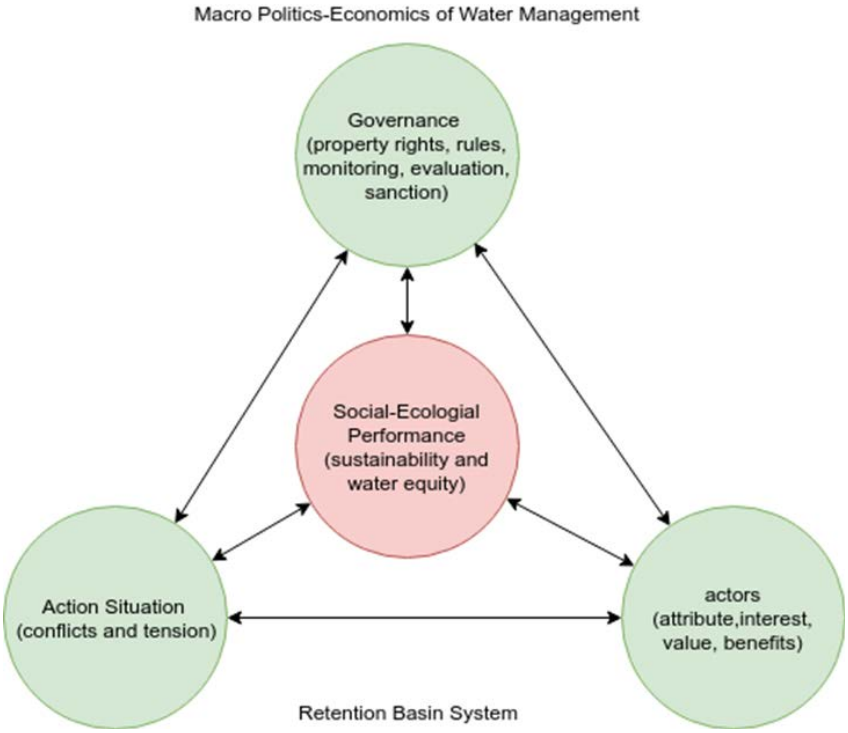

Figure 3. Research Conceptual Framework. Adapted from McGinnis & Ostrom 2014.

Future work

Tenurial systems vary across Indonesia. Failure to address existing tenurial systems would impede efforts of environmental conservation and protection. Studies on evolving local tenurial systems are urgently needed to understand effective ways for establishing local institutions that ensure sustainability of ecological services and equity of resources (Figure 3).

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9. PROMOTING LOCAL FOOD THROUGH TOURISM DEVELOPMENT: A CASE STUDY IN NEMBERALA VILLAGE, ROTE ISLAND, EAST NUSA TENGGARA

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Abstract

Tourism can threaten or open up opportunities for food security in a destination. This qualitative research was conducted in the village of Nemberala, Rote Ndao Regency, to identify the potential of local food that could be developed for tourist consumption. This article is about initiatives proposed by different agents, to help the locals benefit from tourism by expanding agricultural products, and also to promote local food security. With tourism development, locals can benefit from growing plants needed by tourists. Apart from that, another initiative is to introduce them to sorghum flour processing as a substitute for wheat flour. With the initiative, it is expected that locals will be motivated to grow their local agricultural products for their economic added value and positive impacts on food security.

Keywords: tourism, local agriculture, food security

Abstrak

Pariwisata dapat mengancam atau membuka kesempatan bagi ketahanan pangan di daerah tujuan wisata. Penelitian kualitatif ini dilakukan di Desa Nemberala, Rote Ndao Kabupaten untuk mengidentifikasi potensi pangan lokal yang bisa dikembangkan untuk konsumsi turis. Dalam artikel ini akan digambarkan inisiatif oleh agen berbeda untuk membantu masyarakat mendapatkan manfaat pariwisata dengan memperluas produk pertanian dan juga untuk mempromosikan ketahanan pangan lokal. Selain itu, inisiatif lain memperkenalkan mereka pada pemrosesan tepung sorgum sebagai pengganti terigu. Dengan inisiatif tersebut, diharapkan penduduk setempat akan termotivasi untuk mengembangkan produk pertanian lokal agar dapat memperoleh nilai tambah ekonomi yang berdampak positif pada keamanan pangan.

Keywords: pariwisata, pertanian lokal, ketahanan pangan

Introduction

Food security issues are closely linked to tourism development because tourism may boost or deploy local food production. Tourism development may cause food insecurity due to the expansion of tourist facilities at the expense of the agriculture sector. Along with the growing trend of food tourism, local people can respond to the opportunities by introducing their local food to the tourists. Linking local food and tourism has potential to bring positive impacts economically, socially and environmentally to the tourist destination. In fact, tourist expenditure on food makes up one-third of the total expenditure by tourists in a tourist destination (Telfer & Wall 1996), and it means that if a local community can respond to the tourist demand by cultivating local potentials, the practice will improve the local economy significantly. Socially, a community can positively contribute and participate in the tourism development. Environmentally, linking food to tourism may help promote food security because tourism and food security have a cause–effect relationship. When tourism become an alternative livelihood, then the sector can contribute to food security through promoting economic development and local food systems (Ambelu et al. 2018).

This article explores the case of Rote Island, East Nusa Tenggara, with its tourism development and the potential link between local food and tourism development. The potentials and challenges to build up linkages between local agriculture and tourism development as perceived by the local people, and a number of potential solutions, will be presented.

Approach

The research was done in Nemberala Village, West Rote District, using a qualitative approach. We interviewed local residents, tourists and foreign settlers. With the local residents, the interviews explored issues related to their involvement in tourism activities, their livelihood, and agricultural activities of the locals including what they grow, produce and where they sell their yields. We also interviewed foreign tourists and settlers to know the proportion of local agricultural products they consume. Apart from the series of in-depth interviews, we also conducted observations. We observed local people's agricultural activities, and the interactions between tourists and the local community. We recorded all the interviews and transcribed them soon after we returned from the field. To analyse the data we went through thematic analysis and we referred back to our informants through telephone when it was necessary.

Discussion

The majority of the population living in Delha area are farmers. They prefer to live further back inland and only few households live in the coastal area. They only use the coastline areas for growing coconuts. However, now that tourism is developing, the locals rent out their lands along the coastline for foreigners to build their houses and resorts.

The villagers used to rely on dryland farming and have various types of plants to maintain their livelihood. They mainly grow corn, different kinds of nuts, sorghum and foxtail millet. To meet their daily needs, they typically grow vegetables in their backyard such as papaya for their fruit, leaves or flowers, long beans, and pumpkin. Besides that, they also collect sap from the lontar tree (*Borassus flabellifer*) and dry coconut for copra for their livelihood. However, with the tourism development and the introduction of seaweed cultivation, local people have started to reduce their traditional livelihood. Many of them are relying more on income from tourism and seaweed cultivation. In tourism, many locals choose to work in foreign-owned resorts.

Those who remain to be farmers are focused only on products to meet the needs of the locals, although tourists also go to the local market to buy their daily needs. Many fresh products tourists need are not available in the traditional market. As an example, types of fruit and vegetables sold in the market were limited. The farmers only grew watermelon, bananas, mangoes, and papaya for fruit, and water spinach, green mustard, and bean sprouts, chayotes (a type of squash) and cucumber for vegetables. Actually, agriculture products have a good prospect because tourists are willing to buy their products at high prices. For example, when I talked to *Pak* Alex, a local farmer who grew watermelon, he said that to the locals he could only sell one watermelon for Rp 5000 but foreign tourists were willing to pay Rp 10.000 for each melon and usually tourists tend to buy a lot. Sometimes they bought up to 20 watermelons at once.

Different initiatives have been set up to support the sustainability of local agriculture and at the same time help the locals benefit from the tourist development. The first project was run by two Australians who started an organisation to empower the community through education, agriculture, and business development. For agriculture, they gave locals seeds they brought from Australia and encouraged the local people to grow different types of vegetables and spices such as broccoli, beans, oregano, thyme and others in their yards. All these are vegetables and spices needed by foreign households, so that they could sell their products to tourists. However, after the two Australians left, the farmers stopped growing the vegetables and spices because they had difficulties obtaining the seed supplies for the plants.

Another initiative is to introduce post-harvest technology to increase the economic value of sorghum. With the added value, we hope that the farmers will be motivated to grow sorghum to increase local food security. My colleagues and I showed the farmers how they could produce sorghum flour to replace wheat flour which they always had to import from outside. With this initiative, they could reduce their reliance on imported products and at the same time produce unique products for consumption by tourists. Sorghum used to be the food staple of the locals, but fewer and fewer local farmers grow it now they have switched to seaweed cultivation.

According to them, they could not both grow sorghum and cultivate seaweed at the same time. Growing sorghum would require them to watch the plants once the plant yields the grains, to get rid of birds. When we trained the locals to make their own sorghum flour and made brownies and bread out of it, we asked a number of foreign tourists to try. The response was positive. We think that it is necessary for some locals to become pioneers to sell the products to tourists.

Future work

There are still many local agricultural products which can be explored and then modified to meet the tourists' needs for food variations, to improve local food security and to improve local people's economy. Therefore, it is necessary to make the local people aware of the local agricultural potentials they can develop. To meet the objective, dialogues between the two parties – tourists and locals – need to be built up to ensure there is understanding of expectations, from both sides, and so that high quality products can be delivered on time.

Agencies such as NGOs or government need to develop affirmative actions to enable local food and tourism linkage through an entrepreneurship program for the locals, and to help the local agricultural sector to meet the increasing demand from tourists.

Further reading

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Local market, courtesy of Ketut Rudi Utama.

Nira (a sugar palm, probably *Artenza pinnata*), courtesy of Ketut Rudi Utama.

10. WHY THEY WANT TO FARM: A SOCIO-ECONOMIC ENVIRONMENTAL STUDY OF WHY RURAL YOUNG WOMEN CHOOSE TO BECOME FARMERS

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Abstract

Females of all ages play important roles in the biosecurity of the agriculture system. Women comprise 20–50% of agricultural labour in developing countries. For many of them, agriculture is their main job and income. Women in the developing world handle an average of 43% of all farming work and virtually all the household work (FAO 2011; Doss 2011; Thornton et al. 2002 in Bertini 2011). However, they have less access than men to information and training in agriculture. Women learn about agriculture through their experience or by learning from others, but they also need an environment that gives them access to knowledge.

Keywords: agriculture, rural, women, environment, access

Abstrak

Perempuan segala usia memainkan peran penting dalam sistem pertanian. Perempuan terlibat sebanyak 20 hingga 50 persen sebagai tenaga kerja di negara-negara berkembang. Perempuan di negara berkembang menangani rata-rata 43 persen dari semua pertanian dan hampir semua pekerjaan rumah tangga (FAO 2011; Doss 2011; Thornton et al. 2002 in Bertini, 2011). Namun, akses mereka terhadap apa yang mereka butuhkan untuk pemberdayaan dalam pertanian kurang dari laki-laki. Perempuan belajar tentang pertanian melalui pengalaman mereka atau belajar dari yang lain, tetapi mereka juga membutuhkan lingkungan yang diciptakan untuk mereka akses.

Kata kunci: pertanian, pedesaan, wanita, lingkungan, akses

Introduction

In agriculture, in the context of population growth and climate change, two major problems that need more attention are access to the land and desire to become a farmer. First, the access to the land. Tjondronegoro in Iriani (2008) states that the land that people use for farming becomes their main asset because it becomes the main source of their livelihood. However, nowadays, many farmers do not own land for agriculture activities. They lease the land, or they become labourers for other farmers.

The second problem is the reduction in the number of farmers. The 2013 agriculture census noted that in the previous 10 years (2003–2013), the number of households engaged in farming activities was reduced by 5 million. Another problem is related to the age and productivity of the farmers themselves. The age structure of farmers is old – 60.8% are aged over 45 years, with 73.97% having education only up to elementary school level – and their capacity to implement new technology is limited (Wiyono et al. 2015).

The two factors above can directly and indirectly affect plant biodiversity and biosecurity because there is no land to be planted continuously or sustained. On top of that, there is reduced crop cultivation activity because of the reduced number of people who have an interest in becoming farmers, even in the villages. Young people choose to go outside the villages to get cash rather than be farmers.

Approach

This study has applied a descriptive qualitative method. Data collection in this survey was by in-depth interviews and focus group discussions, using guide questions conducted so as to research

the subjects of interest. Guidelines for questions relating to the topic of the survey are tenure systems or rules and procedures governing the rights, obligations, freedom of individuals or groups in terms of the use and control of land and water resources.

This research was conducted during February to June 2019, in 3 villages in Kupang district (Oh Aem 1 village, Oh Aem 2 village and Lelogama village) and 3 villages in South Central Timor district (Bosen village and Taiftob village, and one comparison village Desa Fatumnasi) with a total of 74 participants.

Data source: residents aged between 15 and 60 years, from the participants in the Young Female Farmers (YFF) program and other young farmers (men).

Population: the population referred to in this survey is the target population deliberately chosen to be studied. They are villagers aged between 17 and 60 years, spread through 4 villages and 1 village other than YFF intervention villages as the comparison village.

Sampling: a random sampling method – purposive (that is, subjective), so that all members of the population have the same opportunity to be included in a sample.

Data analysis: using the yEd Graph Editor program by applying the Systems Thinking method.

Discussion

From the data analysis we found 5 major factors that are needed for women to create the environment they need to succeed in agriculture: namely, access to agricultural land, self-motivation, water availability, access to information and knowledge of agricultural cultivation, and certainty of buyers/market opportunities.

There were 74 farmers interviewed, mostly women. When talking about plant biodiversity and also biosecurity, those topics are inseparable from the people involved in maintaining and practising agriculture. Their ways of managing the challenges of climate change can help them in their agricultural work and provide important information for managing biosecurity issues. Some comments from the participants follow, from farmers working on their parents' farms, and from a young female farmer.

> 'What is needed to help as a farmer is clear soil status, availability of water, fruit seeds or longevity plants.' – Farmers who help parents.
>
> 'Not only because of land problems but at that time from the district made an announcement so farmers could no longer plant. We cultivate in the yard of the house and cultivate a little land in the garden.' – Farmers who help parents.
>
> 'In the garden there is a water pipe. Also there are wells or manual wells. There is also help from NGOs. But in the summer, we still experience drought. If we really experience drought, we must stop planting.' – Young Female Farmer.
>
> 'We can plant a lot but constraints in water. Water will be used for consumption or watering vegetables. Even fights often occur in water places. Water must be shared equally.'
> – Farmers who help parents.

Most of the women answer that if they face an obstacle and they do not know how to solve it then they will choose to stop the agriculture activities or reduce the number of plants grown. If they do not stop, they will face harvest failure and that can impact negatively on biodiversity.

Future work

Based on the results of the focus group discussion and the systems thinking analysis, this study found five supporting environmental factors. The five factors are access to agricultural land, self-motivation, water availability, access to information and knowledge of agricultural cultivation, buyer or market opportunity. Therefore, this research proposes three recommendations for future work: namely, (i) increasing motivation by showing young female farmers bright prospects for the agricultural sector, (ii) improving farming skills and knowledge, and (iii) equipping young female farmers to become entrepreneurs, workers, and managers in the rural economy and the rest.

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Above and below: Some rural women in action.

11. THE ROLES OF WOMEN IN DRYLAND AND OTHER PRODUCTION SYSTEMS: AN OVERVIEW

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Abstract

Women play important roles in rural dryland areas as farmers, labourers, and in many other roles. The roles are diverse and changing rapidly due to many factors. However, issues that are quite consistent in dryland areas are that women are often excluded from decision-making processes and have less access to critical resources such as agricultural assets, inputs, and services. By promoting gender equality and women's empowerment, rural communities across countries will gain many benefits such as the increase of agricultural production. The potential gains will vary by region depending on socio-economic, cultural and political aspects. Thus, Participatory Action Research, which combines both research and development work, will be an effective approach to gain a better understanding of the complexity and the diversity of women's roles in dryland areas and other production systems.

Keywords: women's role, dryland areas, participatory action research

Abstrak

Perempuan memiliki peran yang penting di daerah lahan kering sebagai petani, buruh, dan lainnya. Peranan perempuan sangat beragam dan dapat berubah karena dipengaruhi oleh berbagai faktor. Namun, isu-isu yang cukup konsisten ada di area lahan kering adalah bahwa perempuan sering kali tidak dilibatkan di proses pengambilan keputusan dan memiliki keterbatasan dalam mengakses sumberdaya penting seperti aset dan layanan pertanian. Dengan mempromosikan kesetaraan gender dan pemberdayaan perempuan, masyarakat pedesaan di berbagai negara akan mendapatkan banyak manfaat seperti adanya peningkatan di produksi pertanian. Mnfaat yang diperoleh dapat bervariasi di setiap wilayah tergantung pada aspek sosial-ekonomi, budaya dan politik. Oleh karena itu Participatory Action Research, yang dalam pelaksanaannya menggabungkan penelitian dan program pengembangan, akan menjadi pendekatan yang efektif untuk mendapatkan pemahaman yang lebih baik tentang kompleksitas dan keanekaragaman peran perempuan di daerah lahan kering dan sistem produksi lainnya.

Kata kunci: peran perempuan, daerah lahan kering, participatory action research

Introduction

People in dryland face many challenges from environmental, demographic and socio-economic trends, and currently the added threat of climate change. Among all people in dryland areas, rural communities are hit hardest by climate change impacts (ICARDA/CCAFS 2012). Those issues occur because rural communities depend on agriculture for their livelihoods. Therefore, many climate change interventions should be rooted in the agriculture sector and cover various issues including women's participation.

Women in developing countries, including Indonesia, play important roles in the rural economy as farmers, labourers, and entrepreneurs (FAO 2011; ILO 2019). They manage complex households and pursue multiple livelihood strategies, take responsibility for the well-being of their families, and maintain their homes. They are also involved in both crop and livestock production at subsistence and commercial levels; they produce food and cash crops, manage livestock and fish farming, collect fuel and water, engage in trade and marketing, etc. (FAO 2011). In dryland areas, the roles of rural women are almost the same as in other places in the world. However, according to the United Nations Convention to Combat Desertification (2016), women in dryland areas are mostly important as sources of knowledge related to specific dryland environmental management for medicines, food and – most importantly – water.

Women's roles in dryland and other production systems are diverse and changing rapidly around the world due to many factors. The diversity and complexity of the gender systems determined by community norms and values is one of those factors. Therefore, in Indonesia, the roles of rural women might be different in each place due to the diversity of its culture. Yet, one issue that is quite consistent across countries and context is that women often have less access than men to agricultural assets, inputs and services, and to rural employment opportunities (FAO 2011; UNCCD 2016; Akter et al. 2017). They are also often excluded from decision-making processes and denied access to critical resources (UNCCD 2016; Akter et al. 2017).

Approach

Several Participatory Action Research (PAR) approaches have been used to address gender issues in rural communities of dryland areas. According to FAO, PAR is an approach that combines both research and development work. The idea behind this approach is that particular actions or interventions are tested and implemented simultaneously with local partners, researchers, development workers, and other stakeholders collaboratively. The research is conducted while the actions or interventions, which do not always only concern gender issues, are implemented. By using this approach, rural communities not only have the opportunity to take roles in development works in their areas but also give a contribution to research participants. This approach makes the participants not merely subjects of research but, rather, active contributors to research who can participate in all phases of the research process (MacDonald 2012). Moreover, PAR allows researchers to be committed participants, facilitators and learners at the same time during the research process. Both researchers and participants are working together on understanding problematic situations and finding suitable solutions.

PAR is not easy to undertake since it requires collaborative work between researchers and participants while each community has a different situation, social norm, and behaviour. Mapping and analysing the culture of rural communities before taking any further action related to research and intervention is a commonly used strategy. Another challenge in PAR is how to manage extra effort to conduct research while implementing intervention programs. However, PAR is still one of the most effective – and popular – approaches used by many stakeholders to address gender issues in rural communities of dryland areas: such as analysing current roles of women, exploring the current gender gap in dryland areas, developing suitable coping strategies, etc.

PAR facilitates researchers to gain a better understanding of the complexity and the diversity of women's roles in dryland areas since it uses multidisciplinary perspectives and a range of different methods. Most of the time PAR is identified as a qualitative methodology; nevertheless, PAR also uses quantitative methods for particular purposes. Focus group discussions, interviews, observations, and surveys could all be conducted in order to collect representative data and accurate analysis. Selenger (1997, as cited in MacDonald 2012) identified several components in the PAR process. 1) The problem originates in the communities and it should be defined, analysed, and solved by the communities. 2) The ultimate goal of PAR research is the radical transformation of social reality and improvement in the lives of the individuals involved; thus, community members are the primary beneficiaries of the research. 3) PAR involves active participation of the communities at all levels of the research process. 4) PAR encompasses a range of powerless groups of individuals. 5) PAR has the ability to create a greater awareness in individuals' own resources that can mobilise them for self-reliant development. Community participation in the research process provides a more accurate and authentic analysis of social reality.

Discussion

Women are playing big roles in the development of rural and national economies in dryland countries. However, according to FAO (2003), rural women in many dryland countries across Africa, Middle East, Central and South Asia continue to face having limited control or access over productive resources such as land, credit, agricultural inputs, training and extension services. Their productive or agricultural assets, including their labour and output, are generally considered to be less valuable than those of men. The extensive empirical evidence gathered by FAO (2011)

Women have a role in dryland production systems. *Photo by Gary Kong; used with permission*.

shows that female farmers produce less than male farmers not because they are less-efficient farmers; the gap is caused by differences in input use. Most of the time, women have to manage households' responsibilities, unpaid, yet in some particular places in dryland countries women also have to face discrimination in education or employment, have limited access to information or technologies, and are often excluded from decision-making processes in the public sphere.

Promoting gender equality and women's empowerment will benefit rural communities across countries. According to UNDP (2016) empowering rural women could in turn reduce the number of undernourished people by 12–17% or by 100–150 million people, as well as increase resilience against climate change, and preserve land and natural resources. FAO (2011) also mentioned that eliminating the gap between men and women in access to agricultural resources would raise yields on women's farms by 20–30% and increase agricultural production in developing countries by 2.5–4%, considering that women predominate at all production levels of the agricultural value chain: pre-harvest, post-harvest processing, packaging, and marketing. The potential gains however would vary region by region depending on how many women are currently engaged in agriculture, how much production or land they control, how wide a gender gap they face, and their awareness about their rights.

In some cases, women's empowerment programs in dryland areas not only have to deal with community awareness issues but also women's awareness about their own roles and their rights (Forsythe et al. 2015, Nelson et al. 2015). Women themselves sometimes fail to recognise their own invaluable contributions not only to agriculture but also to other socio-economic, cultural and political aspects of life in the communities in rural drylands. Hence, the pathway to securing dryland women's rights is a challenging one. It requires challenging the socio-cultural norms and practices that devalue women's roles and contributions and that prevent their active participation in decision making. It also has to deal with the spatial and political marginality of dryland issues in general. Those issues not only limit women from realising their roles and their full potential both personally and in the workforce, but also could impede overall societal development. The equitable growth and progress of rural dryland areas development cannot be fully realised if women are not given the opportunity to contribute not only with their hands and labour in the field, but also with their thoughts, ideas and creativity in their community.

Future work

To achieve women's empowerment in dryland areas and other production systems there needs to be full recognition of women's rights to participate in the public sphere and to make and influence decisions. In order to gain that, it is necessary to conduct further research into discriminatory attitudes and behaviour that prevent dryland women from realising their rights. Local governments should undertake a gender role analysis together with other stakeholders in order to develop suitable empowerment programs for rural dryland communities. The analysis needs to examine and understand the unique social and cultural contexts that affect gender roles, values, norms and expectations. The issues that need to be addressed are diverse and changing; thus, the actions or the intervention programs should be evaluated continuously over a period of time. The actions or interventions need to be managed on a short-, medium- and long-term basis. Both local and national governments need to keep on reviewing barriers to women's participation in the community, and also identify and share good practices on how to promote gender mainstreaming in dryland areas.

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12. THE CONTRIBUTION OF WOMEN'S COMMUNICATION IN THE FAMILY TOWARDS BIODIVERSITY AND BIOSECURITY ISSUES

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Abstract

Women, especially housewives, play important roles in delivering information in a family. One of the messages that is continually delivered by housewives in their families is about environmental issues, including the topics of plant biodiversity and biosecurity. The contributions of housewives on plant biodiversity and biosecurity issues is related to their daily activities at home. Women have to live in harmony with the environment which is the source of food, livelihood and comfort in their lives. From the communication perspective, women have a communication style that is full of repetition, which makes the messages delivered by them more likely to be remembered by other family members. Based on that, women in the family should be involved in sending messages about biodiversity and biosecurity issues in order to raise family awareness on these topics.

Keywords: women, messages, biodiversity, biosecurity

Abstrak

Perempuan, khususnya ibu rumah tangga, berperan penting dalam memberikan informasi dalam keluarga. Salah satu pesan yang selalu disampaikan oleh para ibu rumah tangga adalah tentang masalah lingkungan, termasuk keanekaragaman dan ketahanan hayati. Kontribusi ibu rumah tangga terhadap keanekaragaman dan ketahanan hayati berkaitan dengan aktivitas keseharian mereka di rumah. Perempuan harus hidup selaras dengan lingkungan yang adalah sumber makanan, sumber mata pencaharian dan kenyamanan hidup mereka. Dalam perspektif komunikasi, gaya komunikasi perempuan yang penuh dengan pengulangan pesan membuat pesan yang mereka sampaikan lebih mudah diingat oleh anggota keluarga lain. Berdasarkan hal itu, perempuan dalam keluarga harus dilibatkan dalam memberikan informasi tentang masalah keragaman dan ketahanan hayati untuk membangun kepedulian keluarga terhadap hal tersebut.

Kata kunci: perempuan, pesan, keragaman hayati, ketahanan hayati

Introduction

Communication as part of human life has contributed many things from one generation to another generation. It is the messages that have been delivered through the communication process from person to person, person to community and also community to person. One of the messages is related to our environment, including biodiversity and biosecurity issues. As we know, disseminating information about biosecurity and biodiversity is not only the task of those who work in agriculture and environmental fields, but also, ideally, a task for all people in the world.

Thus, through communication we can help reduce the problems in plant biodiversity and biosecurity that come up in our lives by thinking out and carefully delivering messages to help solve the problems.

First of all, there should be thorough communication research about biodiversity and biosecurity issues: for example, to identify the biggest problems on plant biodiversity and biosecurity; to find people knowledgeable about these issues; to determine the main messages that should be delivered to people; to decide on the target audiences for the messages; and so on. By analysing the main communication obstacles of biodiversity and biosecurity topics then we could create proper messages to fix the obstacles. Women are one target audience that can be considered for receiving messages about biosecurity and biodiversity – especially the housewife in a family.

A woman and child communicating about threats to a healthy environment.

Approach

This was a qualitative study using the phenomenological method, with housewives and their children in Kupang City, East Nusa Tenggara Province. This study explored the communication experiences of informants within their family about biosecurity and biodiversity messages. The data were gathered through focus group discussions in two different groups: a housewives group and a children group.

Discussion

Deborah Tannen (in Griffin 2004) said that women talk more than men in private communication processes. Since the home or family is a private area, it provides a broad space where women can communicate freely to all family members, including about biodiversity and biosecurity topics. Female communication styles that typically are practised by housewives have resulted in the messages they convey becoming the messages most remembered by their family members. Housewives say they repeat those messages almost every day just to make sure they can be remembered and become good habits within the home and elsewhere (Mas'Amah et al. 2016). Liliweri (2011) says this is one of the advantages of verbal communication or verbal messages – that they can be immediately clarified because housewives as communicators can clarify certain ideas to be instantly understood by the receiver and at the same time can reduce the level of uncertainty.

However, according to the present author's observations, public messages about plant biodiversity and biosecurity are currently still addressed to general audiences and do not particularly target women who obviously have unique ways of communicating in the household.

Darmastuti et al. (2012) have stated that women have a role as educators and first actors, and they understand how to maintain the quality of life through the creation of a healthy environment in their family. The role of women's communication in environmental campaigns in the family is based on some research which found that women's response to environmental change is better than men's because of the 'maintain' characteristic that is naturally owned by women (Darmastuti et al. 2012). Sarwono (2010) explained that women's activities often cannot be separated from the environment. For instance, the work of a village's women in getting clean water to families or for livestock, as well as struggling through droughts, and their concerns about pollution, are because they are the first to be affected by the impacts of unhealthy environmental pollution, or because they are compelled to travel long distances just to obtain firewood when deforestation happens.

Therefore, in order to sustain family life, women have to live in harmony with the environment which is the source of food, livelihood and comfort in their lives.

Future work

The uniqueness of women's communication should be seen as an opportunity to raise awareness within families about plant biosecurity and biodiversity issues. Therefore, women should be more involved in every communication program or every information policy about the issues. Additionally, policy makers and heads of households – who are mostly men – should also be enlightened about this, so that in the future the uniqueness of women's communication methods will be of benefit in every level of society.

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13. COMMUNITY-BASED CLIMATE CHANGE ADAPTATION IN MANAGING BIODIVERSITY AND BIOSECURITY

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Abstract

This paper reports on a program called Community Resilience and Safety, implemented by Indonesian Red Cross in 3 districts and 9 villages of East Nusa Tenggara, Indonesia. The purpose of this program is to improve community awareness and knowledge on climate change adaptation in managing biodiversity and biosecurity. The program is community-based, as an approach to encourage the community itself to manage this problem in every stage of interventions, from planning to implementing and evaluating. Through this approach the community becomes able to understand about climate change, plant biosecurity and biodiversity. Besides that, the community is able to mitigate and adapt to the issues as they happen. The next step will be to suggest to various parties, both government and non-governmental actors and science, that they devise policies to increase and scale-up the resilience of rural communities in plant biodiversity and biosecurity, independently and locally.

Keywords: biodiversity and biosecurity, community-based, climate change

Abstrak

Paper ini akan mengulas tentang program 'Masyarakat aman dan Tangguh' yang telah dilaksanakan oleh Palang Merah Indonesia di 3 kabupaten di 9 desa di Nusa Tenggara Timur. Program ini bertujuan untuk meningkatkan kesadaran dan pengetahuan masyarakat tentang adaptasi perubahan iklim dalam memanagemen Keanekaragaman dan Keamanan Hayati. Community Based merupakan salah satu pendekatan yang melibatkan masyarakat dalam setiap tahapan intervensi program di mana di mulai dari perencanaan, pelaksanaan, dan evaluasi. Melalui pendekatan ini masyarakat menjadi tahu dan dapat memahami tentang bagaimana melindungi keanekaragaman hayati dan ketahanan hayati dalam menghadapi perubahan iklim yang terjadi saat ini. Selain itu, masyarakat mampu memitigasi dan beradaptasi dengan masalah yang terjadi. Kemudian disarankan untuk melakukan advokasi ke berbagai pihak, baik pemerintah maupun aktor non-pemerintah dan ilmu pengetahuan, khususnya kebijakan untuk meningkatkan ketahanan masyarakat pedesaan dalam keanekaragaman hayati dan ketahanan hayati secara mandiri dan lokal.

Kata kunci: keanekaragaman dan ketahanan hayati, berbasis masyarakat, perubahan iklim

Introduction

Climate change is a major issue in the future management of biosecurity and biodiversity. Biodiversity refers to the diversity of all types of plants, animals and microorganisms and also ecosystem processes and ecology (Act No 5 Year 1994 on Ratification of the United Nations Convention on Biological Diversity). Genetic diversity (within species) includes all genetic information as carriers of heredity of all living organisms. Biodiversity is more than the number of flora and fauna species (BAPPENAS 1993).

Biodiversity for humans is like life support. It gives humans our living space, and that living space provides all kinds of life (flora, fauna, etc.) to be managed wisely by humans, while in fact humans themselves are one component of biodiversity. Even so, there are still many people who do not understand the importance of the role of biodiversity as life support. Therefore, at this time it is very urgent to take important steps to increase public awareness of the facts and problems of biodiversity (KLH 1989). All components of society must understand the social and environmental costs of biodiversity degradation. It is necessary to strengthen the capacity and knowledge of the community about biodiversity.

Climate change is a global issue caused by changes in climate parameters such as temperature, rainfall, humidity, wind, cloud conditions, precipitation and solar radiation (Aliadi et al. 2008). Climate change can cause prolonged drought, or conversely excessive rainfall. Global climate change occurs slowly but has a very big impact on life and living things. Climate change affects biodiversity and ecosystems directly and indirectly.

East Nusa Tenggara (ENT) has a dry season that is longer than in other regions, lasting from May to November, while the rainy season lasts only five months, from December to April. In September 2019, 10 regencies in ENT Province experienced drought due to a prolonged summer. To overcome this issue, the community needs to be aware about climate change, and to have strategies and methods to adapt their plantings so they support biodiversity and biosecurity.

Approach

This paper is based on program experience of the writer and on reports from implementing the program in 3 districts. In a 'Community Resilience and Safety' program running in other areas, the communities were able to show resilience and adapt safely to cope with the climate change happening in their area. The program was using 'community-based climate change adaptation', which is an approach that could be used to save biodiversity and biosecurity in the dryland in a time of climate change, through mitigation and adaptation strategies. Mitigation and adaptation strategies to save biodiversity should be known and implemented by all parties, and related to efforts to anticipate the increasing rate of decline of biodiversity as a result of climate change. Human wisdom is one of the keys to success in this effort.

We need to maintain native ecosystems, protecting and increasing the carrying capacity of ecosystems, managing habitats for species which are almost extinct, creating sanctuaries and areas to buffer and form a network of protected land, water and sea areas. Then, using biodiversity in normal life is far better, if done wisely, so as to support the world program in maintaining sustainable development, known as the Sustainable Development Goals.

Discussion

A Community Resilience and Safety program has been implemented in 3 regencies: Belu, Ruteng and Kalabahi. In each district, 3 villages are implementing the program (Belu: Sarabau, rafae and fatuketi; Ruteng: Ranaka, gapong and Ndehes; Alor: Kolana Selatan, Kopidil and Wolwal) in ENT. This program is run by the Indonesian Red Cross and funded by the Australian Red Cross. In implementing this program they have used a community-based approach in implementing every activity through planning, implementation and evaluation.

The contributions made by the program using the community-based approach included, firstly, building understanding about climate change adaptation and why the approach was being used. After building their capacity, the community chose and formed the 'preparedness' committee of volunteers from the across the whole village community. These committees of volunteers were to represent and lead the community in mitigating their problem. Then all activities to mitigate and adapt to climate change were led by the volunteer committee itself.

The village volunteers, from the start, persuade the right people and parties to be involved in the participatory process of climate change adaptation which must be integrated in development plans and programs. Among the people and parties involved are, for example, village government, indigenous people, teachers, priests and young people. They sit together to discuss the steps to be taken to adapt to climate change, and they produce decisions through a comprehensive process. Then, the community identifies vulnerabilities, including current risks and potential risks. After determining the people and related parties, the next step is to identify the risks and threats of climate change, both current risks and long-term risks.

Adaptation capacity assessment relates to the property owned by the parties involved in the adaptation process to adapt to climate change. This assessment of adaptation capacity is important to reduce risks due to climate change.

Identify adaptation options is the next step, to identify possible adaptation options based on risk analysis and assessment of adaptation capacity.

The implementation phase is the stage of implementing adaptation options that have been decided on as necessary in adapting to climate change.

After risk analysis and assessment of adaption capacity, the community applies mitigation strategies suited to the issues that they have in that village: for example, water source conservation, forest conservation, agroforestry conservation (coffee plants), river bank conservation, landslide conservation and agricultural adaption.

Then they evaluate the choices. The adaptation options have been identified, and these options need to be chosen based on effectiveness, ease of implementation, acceptance by the local community, support from experts, and the resulting social impact.

Monitor and evaluate adaptation. The final stage is to monitor the implementation and to evaluate the adaptation options. Because the adaptation process is an ongoing process, filled with variability, and the costs incurred are difficult to calculate or predict, monitoring and evaluation of adaptation options needs to be done.

This program has carried out activities related to climate change adaptation but has not been implemented in all regions in ENT.

Future work

A community-based approach is a good way to adapt and mitigate the impacts of climate change so as to protect and save plant biosecurity and biodiversity in villages. Therefore, it is important to give out information and increase general knowledge and awareness on biosecurity and biodiversity among the community, so that they can adapt and mitigate climate change effects.

Based on the results experienced so far, climate change adaptation related to the protection of biodiversity needs to be considered by all sectoral institutions in the government, NGOs, INGOs, and also the private sector. They need to provide capacity building to the community, related to efforts to adapt to current climate change in accordance with the local context in each region, to protect biodiversity and biosecurity. This program also should be scaled up to all villages in ENT so that the communities have the same awareness, capacity and knowledge to adapt and mitigate the effects of climate change, so as to protect and save the local biosecurity and biodiversity.

Also, the experience of the community-based program in climate change adaptation must be documented so that it can be replicated in other regions in Indonesia, and facilitate the exchange of knowledge between communities in Indonesia related to climate change adaptation, including what has been done by the ENT community.

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14. PLANTS AS INDICATORS OF POLLUTION

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Abstract

Intense human activity can cause environmental pollution, creating biosecurity risks and endangering biodiversity. Measurement of pollution levels uses pollution parameters. One example is the pH, which is the acidity or alkalinity of an area, and it can be measured using indicator paper. Prices of commercial indicator paper are relatively high, so the amounts available are limited. An inexpensive and environmentally friendly type of indicator paper needs to be developed. This desktop study has found that plants can be used as indicators of an area's pH, which may result from pollution.

Keywords: pH, plants, indicator

Abstrak

Aktivitas manusia yang tinggi dapat menyebabkan pencemaran lingkungan, menciptakan risiko biosekuriti dan membahayakan keanekaragaman hayati. Pengukuran tingkat pencemaran menggunakan parameter pencemaran. Salah satu contoh parameter pencemaran adalah pH. pH merupakan tingkat keasamaan suatu daerah yang diukur menggunakan kertas indikator. Harga kertas indikator yang beredar di pasaran relatif mahal sehingga jumlahnya terbatas. Pengembangan kertas indikator yang murah dan ramah lingkungan harus dilakukan. Studi literatur dilakukan dan disarankan menggunakan tumbuhan sebagai indikator.

Kata kunci: pH, tumbuhan, indikator

Introduction

Intense human activity can cause environmental pollution, creating biosecurity risks and endangering biodiversity. Human activities produce waste. Waste that is discharged into the environment will cause the environment to become polluted. A polluted environment can threaten biodiversity and increase the risk of diseases in plants, especially food crops.

Work is needed to counteract pollution of the environment. The first step is to find out the level of environmental pollution. Measurement of pollution levels uses pollution parameters (Rahmani 2015), which can be physical parameters, chemical parameters and biological parameters. One chemical parameter is pH, which is the degree of acidity or alkalinity of an area (Roziaty et al. 2017), and it is often measured using indicator paper.

The price of indicator paper is quite high in the market so its use is limited. Also, commercially produced indicator paper is not environmentally friendly. Therefore, it is necessary to develop indicators that are cheap and environmentally friendly. The approach suggested here is relatively easy to use and tends to be cheap. Indicators can be made from plants. The costs are therefore limited to ethanol and human resources, making the proposed solution accessible and easy.

Approach

This research has used a desktop study to develop the suggestion of a new and cheaper method of testing pollution. Indicators for testing pH can be made from plants. They change colour according to environmental conditions.

Discussion

Natural indicators can be made by using anthocyanin substances in plants (Virliantari et al. 2018). The term 'anthocyanin' is derived from the Greek words for flower (*anthos*) and blue (*kyanos*). Anthocyanins are water-soluble vacuolar pigments, with colours that appear red, purple or blue

depending on the pH of the solution where the compound is located. Anthocyanin is present at high concentrations in almost all plant tissue, including leaves, stems, roots, flowers, and fruits (Santoso & Sri Mulyono 2015).

Bougainvillea flower (*Bougainvillea spectabilis* Willd). *Photo:* Made Santiari.

Researchers (Mahmud et al. 2019) have identified the following plants that can be used as indicators at Kupang: purple cabbage (*Brassica oleracea* Capitata Group), red Turi flower (*Sesbania grandiflora* L.Pers), starfruit flower (*Averrhoa bilimbi* L), red cactus fruit (*Opuntia vulgaris* Mill), Ruellia flower (*Ruellia simplex*), Flamboyant flower (*Delonix regia*), bougainvillea flower (*Bougainvillea spectabilis* Willd), red spinach leaf (*Amaranthus tricolor* L.), Murbey fruit (*Morus alba* L.,), turmeric (*Curcuma longa* Linn) and oyster plant leaf (*Rhoeo discolor*). The researchers also examined colour changes when plant extracts were added to acidic and alkaline solutions, as shown in Table 1.

The change in colour shows the potential of the plant as an indicator of acidity or alkalinity (Mahmud et al. 2019). These plants are available in Kupang city on Timor Island, and therefore may be available for use as indicators across Timor Island.

Table 1. Colour changes in two acid solutions and two alkaline solutions after adding plant extracts.

Source: Mahmud et al. 2019

Sample extract	Initial colour of extract	Discolouration due to addition of extracts in solution				Classification of indicators
		H_2SO_4 Sulphuric acid	CH_3COOH Acetic acid	NaOH Sodium hydroxide	$NaHCO_3$ Sodium bicarbonate	
Purple cabbage *	Dark purple	Red	Pink	Green	Greenish blue	Universal
Red Turi flowers *	Purple	Red	Light pink	Dark green	Blackish green	Universal
Starfruit flower *	Bright red	Red	Pink	Blackish green	Dark purple	Universal
Red Cactus fruit *	Red	Dark red	Red	Yellow	Purplish red	Alkaline indicator
Ruellia flower	Blackish purple	Pink	Light pink	Yellow	Green	Universal
Flamboyant flower	Orange	Red	Pink	Dark green	Yellow	Universal
Bougenvillea flower	Reddish purple	Purple	Pink	Orange	Dark purple	Universal
Red spinach leaf	Blackish red	Pink	Pink	Light green	Grayish purple	Alkaline indicator
Jamblang fruit	Purple	Red	Pink	Green	Light blue	Universal
Murbey fruit	Purple	Red	Pink	Dark green	Blackish purple	Universal
Turmeric	Yellow	Light yellow	Light yellow	Reddish orange	Orange	Alkaline indicator
Pineapple shells	Purple	Reddish orange	Pink	Yellowish green	Green	Universal

*Nur Adawiyah et al. 2017 in Mahmud et al. 2019.

Future work

These new indicators should provide additional information about soil conditions where plants are growing in Indonesia, especially Timor, which should help maintain plant biodiversity. In order to test the validity of this proposal, the next step is further testing of the anthocyanin compounds in collaboration with biochemists, and the pH ranges of plant indicators in collaboration with chemists.

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BIODIVERSITY AND BIOSECURITY RISKS AND RESPONSES IN A TIME OF CLIMATE CHANGE

15. ***Don H. Kadja***
    Remote microscopy in the field of plant protection and management of biodiversity in East Nusa Tenggara

16. ***Ruth Feti Rahayuniati & Sri Widinugraheni***
    Detection of banana bunchy top virus (BBTV) in Sumba Island, East Nusa Tenggara

17. ***Origenes Boy Kapitan, Alexander Kehi Klau & Anna Tefa***
    Tembelekan leaf powder as a potential biopesticide for the maize weevil

18. ***Paulina M.D. Hipir & Maria Lobo***
    Predator–prey equations in relation to the biodiversity concept

19. ***Tri Yulianti Nepa Fay***
    Organic farming: solutions towards farmer attitudes in using high dosage pesticides

20. ***Robert Eduard Suek***
    Miracle in Timor Island

15. REMOTE MICROSCOPY IN THE FIELD OF PLANT PROTECTION AND MANAGEMENT OF BIODIVERSITY IN EAST NUSA TENGGARA

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Abstract

Many agricultural practitioners have difficulties when dealing with the identification of pests and diseases. Because of the variety of organisms discovered it takes a very long-term study to be able to do identification correctly. One of the tools established to assist in pest identification is a remote microscope. With this tool, identification activities can be carried out together by several people in different places. This is possible because this microscope is connected with software called *Pestpoint®. Everyone who is involved in identification is connected to these apps online so everyone can see the object they want to identify in real time. Discussion in Pestpoint® is not limited to the identification of pests and diseases, but can extend to other matters including possible control methods.

Keywords: remote microscope, pest, identification

Abstrak

Banyak praktisi pertanian mengalami kesulitan ketika berhadapan dengan identifikasi hama dan penyakit. karena beragamnya organisme yang ditemukan sehingga Butuh waktu yang sangat Panjang untuk bisa melakukan identifikasi secara benar. Salah satu alat bantu identifikasi adalah mikroskop jarak jauh. Melalui alat ini kegiatan identifikasi bisa dilakukan secara Bersama-sama oleh beberapa orang di tempat yang berbeda-beda. Hal ini dimungkinkan karena mikroskop ini dihubungkan dengan dengan software yang disebut pestpoint. Setiap orang yang terkoneksi dengan apps ini secara online dapat melihat obyek yang ingin diidentifikasi secara real time. Diskusi dalam pestpoint tidak hanya terbatas pada identifikasi hama, tetapi mengenai mengenai saran pengendalian.

Kata Kunci: mikroskop jarak jauh, hama, identifikasi, Pestpoint®

Introduction

Since humans started farming thousands of years ago, crop damage from attack by other organisms has always been a part of cultivation activities. The cultivation activity itself is basically a human effort that is done intentionally to cultivate plants to meet the needs of clothing, food, and human shelter. Normally human needs for food continue to change, both in quality and quantity, and will continue to increase because of growth of the human population and cultural development. Humans' efforts to manipulate the agricultural ecosystem to meet their needs do not always run as expected, encountering many obstacles and constraints. One of the main obstacles experienced by every agricultural practitioner comes from the disruption caused by various types of competing animals, which take part in consuming various part of the plants cultivated by humans.

To meet humans' ever-increasing needs, plant cultivation activities become more intensive, which automatically increases human competition with herbivorous organisms which damage their plants (Tefera & Desalegn 2017). Because of the losses they cause, these competitors are categorised as human enemies or harmful pests and must be eradicated. Through the application of science and technology including plant protection technology, humans always try to minimise losses caused by pests. Often the aim is to reduce the pest population by killing it. Sometimes these efforts will result in reduced biodiversity in the managed ecosystem.

Correct control measures to be taken must be based on a good recognition of pests (Kong 2013), not just to control the target pest but also not to damage the environment by killing non-target

organisms. The biggest obstacle faced is the long distance between experts who have pest identification expertise, and the agricultural practitioners, thus hampering communication between these parties. Therefore a remote microscope has been developed to bridge this gap (Thompson et al. 2011), which can indirectly preserve biodiversity in agroecosystems.

Approach

The University of Nusa Cendana (UNDANA) has an established focus on pests and diseases of dryland areas. The method used in the activity reported here was training, which was facilitated by the installation of a remote microscope as part of collaboration with Australia's Plant Biosecurity Cooperative Research Centre (PBCRC).

A series of remote microscope activities was carried out in several stages over approximately two years. At first the introduction of the remote microscope was carried out by Dr Gary Kong (PBCRC) to experts and students at UNDANA. It included how to install a remote microscope, the advantages of remote microscopes compared to microscopes in campus' laboratories, how to operate them, and how to collaborate with Pestpoint® to get satisfactory results.

After this initial training several farmer groups and field extension officers were invited to take part in similar training, delivered by experts at the University of Nusa Cendana and accompanied by Dr Gary Kong and Mr Michael Thompson. Training for farmers was carried out in the Integrated archipelagic dryland Field Laboratory and followed by a field visit. This field visit was conducted to train farmers and extension officers to use tools related to remote microscopes directly, because it was realised that the use of these tools in the field has its own advantages and challenges that require special expertise (Kong 2013); for example, to take pictures of pests showing their details so they can be posted on Pestpoint® and easily recognised by other people in the group, or even by people from outside the group who were invited to solve problems encountered in the group. In addition to training activities, discussions involving all stakeholders were also held to obtain information about the problems of pest management and to share the perception of agricultural management in general and pest management more specifically.

These approaches also aim to show farmers that recognition of the organisms in their agricultural environment is essential, to know how to improve the quality of sustainable agricultural management. In addition, it is expected that the technology will promote a wider and more intense communication network between farmers and all agricultural stakeholders.

Discussion

The introduction and training in use of remote microscopes was attended by some 17 farmers, 14 lecturers, 5 agricultural extension officers and 15 students. At the beginning of the training, farmers focused more on the pests and diseases present in their crops, and assumed that all these organisms were pests and had to be eradicated. But after attending the training, farmers realised that not all living things on their farms were pests. After doing field practice and seeing symptoms of pests and diseases, and taking pictures of pests and other insects in the agricultural environment, farmers became more aware of the importance of the presence of non-pest organisms in agricultural fields.

In the discussion session it was also finally realised that there were many obstacles which created a gap between the stakeholders. The biggest obstacle in this country, just like in other countries, was communication (Moran & Muirhead 2002). A lot of information was only held at a certain level, for example the type of pest and its attack cycle were only known by farmers and not known by the agriculture department, which in this case were agricultural extension officers. Yet it was also realised that the best planning for a sustainable agricultural system at the farmer, district, city, provincial and national levels must be based on accurate agricultural information in the field.

Quite a lot of information about pests and plant diseases in the dryland area has been uploaded into the database system contained in Pestpoint®, an app that was intentionally designed and combined with the remote microscope to manage a user-friendly database of plant pests and diseases.

In this activity the main focus of discussion was assistive devices (remote microscopes) which are generally used in identification, but other issues relating to agriculture as a whole were also alluded to; for example, about the role of other organisms in the agricultural environment. After a series of activities, farmers have become more aware that in managing the agricultural environment, knowledge of living things associated with crops becomes a very important thing to know and to manage in order to make agriculture become more stable and sustainable (Brzozowski & Mazourek 2018). At the end of these activities agricultural practitioners were more familiar with biodiversity in dryland areas in general and the agricultural environment in particular.

Future work

The use of a remote microscope is very helpful for agricultural practitioners, but putting data into an application that is in English remains an obstacle. Therefore, if there are parties who can design a similar application in Bahasa Indonesia, it will certainly be very helpful for stakeholders in East Nusa Tenggara and other regions.

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16. DETECTION OF BANANA BUNCHY TOP VIRUS (BBTV) IN SUMBA ISLAND, EAST NUSA TENGGARA

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Abstract

Banana Bunchy Top Virus (BBTV) has become greatly of concern in banana production worldwide. In the field, this virus infection is mostly found in the edible banana. However, there are no reports so far of BBTV infecting wild banana. This study is aimed at mapping the BBTV presence and distribution in Sumba and at confirming the pathogenicity in both the wild-type and edible bananas. Samples of leaves with BBTV symptoms were collected from Sumba Island, East Nusa Tenggara. The BBTV isolates were identified using the PCR (polymerase chain reaction) test, targeted at the R-DNA genome of BBTV.

Keywords: BBTV, distribution diversity, banana wild-type

Abstrak

Banana Bunchy Top Virus (BBTV) menjadi kendala besar bagi produksi pisang di dunia. Infeksi virus di lapang umumnya ditemukan pada pisang makan dan jarang ditemukan pada pisang liar. Studi ini ditujukan untuk memetakan distribusi BBTV di Indonesia dan mengkonfirmasi patogenisitasnya pada pisang liar. Koleksi daun pisang yang terinfeksi BBTV dari Sumba digunakan untuk deteksi isolat BBTV dengan PCR dengan target R-genome dari BBTV.

Kata Kunci: BBTV, distribusi, pisang liar

Introduction

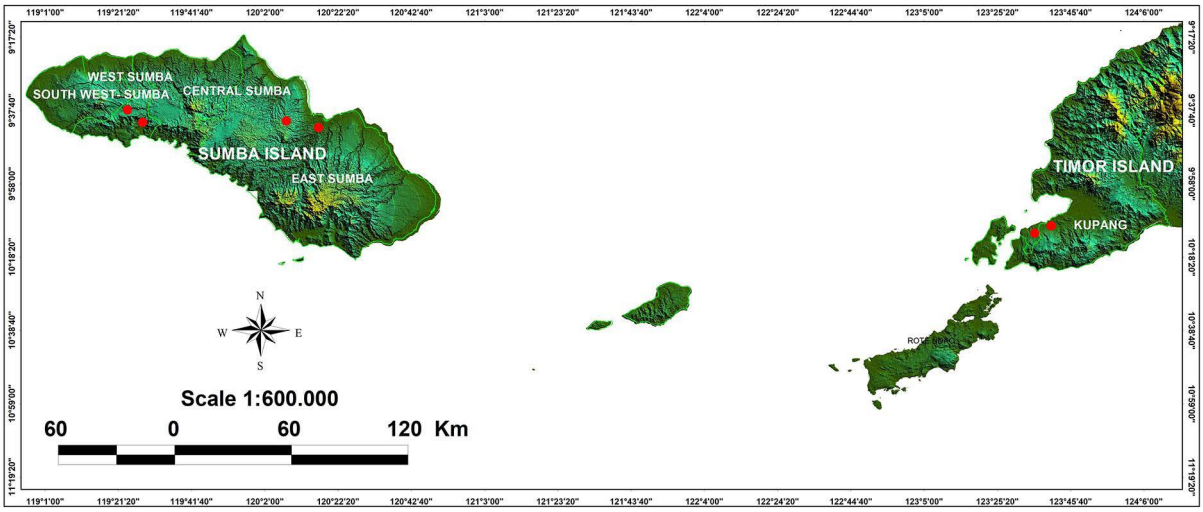
Banana bunchy top disease (BBTD) is amongst the most devastating diseases of banana, along with *Fusarium* wilt and Banana Blood Disease. The BBTD is caused by a plant virus in the genus *Babuvirus* in the Nanoviridae family, namely Banana Bunchy Top Virus (BBTV).

BBTV's genome consists of six components of single-stranded singular DNA (DNA-R, -U3, -S, -M, -C, and -N), 1 kilobase pair (kb) in size for each component. Every single component has potentially encoded one protein, but especially for DNA-R which encodes two proteins, including the master replication protein (M-rep) (Herrera-Valencia et al. 2006). Analysis of the DNA-R sequence from different countries showed differences based on the geographical origin (Karan et al. 1994).

The virus is transmitted by aphids, *Pentalonia nigronevosa* coq., in a persistent circulative (but not propagative) manner. In this case, the virus only follows the circulation path within the aphid's body (Watanabe et al. 2013). The BBTV symptoms on banana are necrosis on the leaf edge, a dot–dash (Morse) sign at the stalk and the lamina, and smaller size (Fu et al. 2009). BBTV may infect almost all the plants in genus *Musa*, such as *M. textilis* (Abaca), and *Ensete ventricosum*. It also infects *Alpinia*, *Heliconia*, *Canna* and *Strelitzia* and also can be found in *Colocasia esculetum* (Kumar et al., 2011).

There is no report on the distribution of BBTV throughout Indonesia so far, especially in eastern parts of Indonesia. Research conducted on BBTV has only reported isolates from Sumatera, Java and Bali. In those reports the BBTV was shown to be present in edible banana, but not reported yet in the wild-type banana.

This study reports on the distribution of BBTV in Sumba, based on early detection using molecular techniques.



BBTV sampling sites on Sumba Island and in Kupang indicated as red dots.

Approach and Outcomes

Sample collection and PCR detection of BBTV isolates

Sampling was done by collecting BBTV symptomatic leaves of banana deliberately, either from commercial orchards or from roadsides or residential plantations as well as from the wild. For each district in Sumba, one to ten spots approximately were surveyed for each variety of banana with bunchy top symptoms. Samples of young leaves were collected from both symptomatic and symptomless or mildly affected trees.

Each sample was stored in a paper bag or thick envelope and coded based on the location origin before being transferred to the laboratory. The presence of insect vectors was also observed on each plant, including on healthy bananas and on alternative hosts around the BBTV sample tree, such as caladium, ginger, etc.

The PCR (polymerase chain reaction) test was applied to the total DNA from leaves, extracted using a Plant Genomic DNA extraction kit (Geneaid). According to Stainton et al. (2012), BBTV can be detected using primer pairs of DNA-R, BBTVF (5'-TTGAGAAACGAAAGGGRAGC-3') for forward primer and BBTVR (5'-GGTGTGCGCCTGGGAAG-3'), producing 1100 base pairs (bp).

Discussion

The disease outbreak was first reported in 1889 in Fiji. In most cases, a loss of 90–95% of banana cv. Cavendish was observed (Mukwa et al. 2014). According to Chen & Hu (2013), people movements can be the cause of the disease spreading. The disease has also caused huge fruit loss as well as damaging fruit quality (Anandhi et al. 2007; Kumar et al. 2015). Decreased fruit quality, impaired plant growth, chlorosis, and sometimes mosaic as well, were observed (Oben et al. 2015). In Tamil Nadu state, India, the cultivation area of banana cv. Virupakshi has been reduced from 18,000 to 2,000 ha because of the disease. The incidence of BBTD in the region is recorded as 14–72% during May 2009 (Elayabalan et al. 2015). In Australia, exclusion of BBTD is thought to have prevented annual losses worth Aus$15.9–$27 million for the banana industry (Cook et al. 2012). Currently BBTV has been reported in 36 countries globally: 14 in Africa and 22 in Asia and Oceania (Kumar et al. 2011).

As many kinds of banana grow well in Indonesia, both the wild-type and the edible banana, as well as the ornamental bananas, the BBTV is as varied. BBTV was first reported in Indonesia in 1978 and it was detected in West Java and Bali. Then BBTV spread into other provinces such as Riau, West Sumatera, Lampung, Central Java and Yogyakarta, with disease outbreaks in Lampung and Central Java (Sulyo & Setyobudi 1988 in Nurhadi & Setyobudi 1998).

Molecular characterisation of BBTV was done with the isolates from Java (Priani et al. 2010), and for Bali isolates by Pinili et al. (2011). The genetic structure and diversity of BBTV in Sumatera has been analysed by Chiaki et al. (2015), and it was found that there are two types of stem-loop common regions of DNA-U3 in Sumatra isolates, namely CR-SL type A (discovered on the isolate from North Sumatra, West Sumatra and Riau, Taiwan, Pakistan, India and China) and CR-SL type B (only discovered on the isolate from the south region of Sumatra island, Pakistan, Tonga, China, and Rwanda).

Our results (Table 1) suggest that BBTV was present at almost all locations surveyed in Kupang and Sumba.

Table 1. Detection of BBTV of isolates from Sumba and nearby locations.

No	Code	Region	Cultivar	Genome	Origin	BBTV
1	KOE001	Kupang	Ambon	AAA	Undana	Positive
2	KOE002	Kupang	Ambon	AAA	Undana	Positive
3	KOE003	Kupang	Raja	AAB	Taman Arjuna, Amnesi	Positive
4	KOE004	Kupang	Unknown	n/a	Hotel Neo El Tari	Positive
5	KOE005	Kupang	Raja	AAB	Labat, Amnesi	Positive
6	KOE006	Kupang	Mas	AA	Baun, Lodi Ismau	Positive
7	KOE007	Kupang	Ambon	AAA	Baun, Lodi Ismau	Positive
8	KOE008	Kupang	Unknown	n/a	Pambotanjara	Negative
9	KOE009	Sumba	Mas	AA	Waikabubak	Positive
10	KOE010	Sumba	Raja	AAB	Maiwata	Negative
11	KOE011	Sumba	Raja	AAB	Lambanapu	Positive
12 &13			Wild banana		Sumba	Negative

Future work

Biosecurity is about protection of germplasm against harmful agents. As Indonesia is the centre of biodiversity and part of it is the centre of banana diversity, it is really crucial now to apply biosecurity measures to protect banana varieties, either the wild or the cultivated edible banana, from diseases such as BBTD. To achieve this, collaborations amongst the people in Indonesia from a range of different backgrounds and locations are urgently needed. Further building a network of research collaboration with neighbouring countries will also be helpful in dealing with the challenge of banana diseases. It is important to form a community and network as soon as possible.

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17. TEMBELEKAN LEAF POWDER AS A POTENTIAL BIOPESTICIDE FOR THE MAIZE WEEVIL

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Abstract

Insect pest occurrence is likely to change in times of climate change, so understanding pests better will assist with biosecurity measures and sustaining biosecurity. Maize weevil is well known as one of the most destructive pests that can damage maize kernels during the storage period. Plants grown under specific conditions have long been known to produce a variety of distinctive secondary metabolites that can potentially act as repellents for different kinds of pest. Tembelekan plants from Timor region, which has a semi-arid tropical climate, were explored for their potential application as a repellent to maize weevil. The results showed that the tembelekan leaf flour was able to reduce the amount of pest damage in the maize kernels.

Keywords: *Sitophilus zeamais* Motsch, *Lantana camara*, biopesticide

Abstrak

Kemunculan hama cenderung berubah seiring perubahan iklim yang terjadi sehingga pemahaman tentang hama akan membantu dalam langkah penanganan dan keberlanjutan ketahanan hayati. Salah satu hama yang merusak biji jagung selama periode penyimpanan adalah kumbang bubuk jagung. Tanaman tembelekan memproduksi senyawa metabolit sekunder tertentu yang berperan sebagai repellent bagi hama kumbang bubuk jagung. Pulau Timor yang beriklim semiarid tropis mengakibatkan tanaman tembelekan dapat memproduksi senyawa-senyawa khas yang dapat dimanfaatkan untuk menekan maupun mengusir hama S. zeamais. Hasil penelitian menunjukkan bahwa tepung daun tembelekan mampu menekan serangan hama yang teramati pada kerusakan biji jagung yang paling rendah.

Kata kunci: *Sitophilus zeamais* Motsch, *Lantana camara*, biopestisida

Introduction

Climate change is causing increases of temperatures and extended droughts. This is predicted to have a profound effect on the geographical distribution, population dynamics and status of stored-product insect pests (Roy et al. 2009). The climate changes can lead to changes in the rate of development of pest populations, and an increased number of generations of stored-product insect pests (Moses et al. 2015). In tropical regions, insect pests infesting stored grains inflict 20–30% damage to maize grain, because of favourable conditions for the pests' development and also poor storage conditions. It has been reported that more than 37 species of insect are associated with stored maize grain (Tadesse 1997). Among them, maize weevil (*Sitophilus zeamais* Motsch) is well known as one of the destructive pests that can damage maize kernels during the storage period. Maize weevil devours the seed completely from inside, making them chaffy and eventually reducing the seed viability.

Plant-derived pesticides can be made available to help the small-scale farmer apply natural crop protection. Plant growth under specific conditions (of soil and climate) has long been known to produce types of distinctive secondary metabolites that can potentially act as repellents for pests. Repellents derived from plants are more desirable than synthetic chemicals as they offer protection with less impact on the ecosystem. It is known that natural bioactive compounds can drive away insect pests from treated material by stimulating insects' olfactory or other receptors (Rajashekar et al. 2012).

In this research secondary metabolites produced by tembelakan (*Lantana camara* L.) plants from Timor, which has a semi-arid tropical climate, were explored for their potential application as repellents to maize weevil. Particularly, this study aims at determining the potential effect of tembelekan leaf powder in controlling the maize weevil.

Approach

A completely randomised design was used in this study. The first factor is the dose of the powdered flour which consists of four levels: T0: no flour 0% by weight (w/w), T1: 10% w/w, T2: 15% w/w, and T3: 20% w/w. The second factor is the storage contact time which consists of four levels: M0: 1 week, M1: 2 weeks, M2: 3 weeks and M3: 4 weeks. The number of insect-damaged grains was counted and maize weevil mortality was observed.

Results and discussion

The result showed that the use of 20% w/w tembelekan leaf powder for 2 weeks storage time was able to reduce pest damage to the maize kernels to a low level. The highest pest mortality was produced by tembelekan leaf flour treatment T2, 15% w/w. It was observed that maize weevils that were treated using tembelekan leaf powder had less active movement compared to the 'no flour' treatment.

Tembelekan leaf flour can be therefore be used to prevent maize kernel damage during storage (for use as seed for the next crop) by mixing the maize kernels with powdered tembelekan leaf. The powdered tembelekan leaf flour has potential as a plant-derived pesticide, to help the small-scale farmers in Timor. Farmers can apply the tembelekan leaf flour to prevent seed deterioration during storage periods.

Future work

As part of future work, it is expected that the chemical components of tembelekan leaf powder will be explored in collaboration with organic chemists in order to determine the primary compounds that play a significant role in stimulating the olfactory or other receptors of the maize weevil.

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18. PREDATOR–PREY EQUATIONS IN RELATION TO THE BIODIVERSITY CONCEPT

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Abstract

The phenomenon where many species coexist in the same space is real. The species interaction discussed in this paper is predator–prey. Parameter values used are prey growth coefficient a = 0.1, predator decay rate coefficient c = 0.08, interaction of predator and prey coefficients (α and γ) α = 0.0014 and γ = 0.0012, time t = 50 days and step size h = 0.1; 0.5 and 1.0. The selection of h values influence the number of iterations and the level of accuracy in the calculations. The results showed that the equilibrium system happens when the number of prey (x) and predators (y) are x(50) = 68, y(50) = 72.

Keywords: predator–prey, mutualism, Runge-Kutta Fourth Order Method

Abstrak

Dalam kehidupan nyata kita menemukan banyak fenomena di mana lebih dari satu spesies hidup di tempat yang sama dan berinteraksi satu sama lain. Jenis interaksi yang dibahas di sini adalah interaksi predator-prey. Interaksi ini kemudian dimodelkan dalam sistem persamaan matematika dan Metode Runge-Kutta Orde Empat digunakan untuk menganalisa keseimbangan sistem. Parameter-parameter yang digunakan adalah koefisien laju pertumbuhan mangsa a = 0.1; koefisien laju kematian pemangsa c = 0.08; koefisien interaksi antar mangsa dan pemangsa (α dan γ) dengan α = 0.0014 dan γ = 0.0012, waktu t = 50 hari dan interval waktu h adalah h = 0.1; 0.5 dan 1.0. Pemilihan nilai h ini berpengaruh terhadap banyaknya iterasi dan tingkat ketelitian perhitungan. Hasil analisa menunjukan keseimbangan sistem dapat terjadi apabila nilai mangsa (x) dan pemangsa (y) sebesar x(50) = 68, y(50) = 72.

Kata kunci: predator–prey, mutualisme, Metode Runge-Kutta Orde Empat

Introduction

The phenomenon where many species coexist in the same space is real. Interactions can occur between individuals within the same species, between different species or even between individuals from different species. When the interactions give benefits or positive impacts to both parties, we say the interactions are 'mutualistic'. However, the interactions can cause negative impact to one of the species and positive to others. This interaction is known as a predator–prey interaction. This type of relation will have an impact on the surrounding environment or on the inhabited ecosystem.

An ecosystem is an ecological system formed by an inseparable interrelationship between living things and their environment. An ecosystem can also be seen as a whole and comprehensive order of unity among all elements of the environment that influence each other. In ecosystems, organisms in a community develop together with the physical environment as a system. Organisms will adapt to the physical environment; organisms may also affect the physical environment for their life purposes. The presence, abundance and distribution of a species in an ecosystem is determined by the level of availability of resources and the conditions of chemical and physical factors which must be within the range that can be tolerated by these species. This is called the law of tolerance. Basically, in ecosystems the biodiversity is interrelated; the number of each species is different and the differences in the numbers of the species will affect the ecosystem cycle.

Mathematicians are interested in determining the number of both prey organisms and predators in order that the biodiversity remains stable in the long term.

Problem statement

What is the dynamic of the number of prey organisms as well as the predators in a particular space, when the biodiversity condition can be maintained?

Approach

To solve the above question, a mathematical model is formulated and 4th Order Runge Kutta Method using the Lotka–Volterra equation is employed. This will help us to determine the number of predators and prey organisms in an ecosystem so that we can find changes in the ecosystem cycle.

Procedure

The steps are as follows:

- Construct mathematical models (based on assumptions)
- Apply stability analysis on the model
- Employ 4th order Runge Kutta Method (using Matlab Software).
- Interpret the solutions.

Discussion

The mathematical models formulated are:

$$dx/dt = ax - \alpha xy$$

$$dy/dt = -cy + \gamma xy$$

where x denotes the number of prey and y the number of predators, t is time and α and γ are the interaction parameters.

Numerical simulation shows that with the values of parameters a = 0.1, c = 0.08, α = 0.0014, γ = 0.0012 and h = 1 and the initial values x(0) = 67, y(0) = 71, then at t = 50 we obtain the values x(50) = 68 and y(50) = 72.

We can see here that both species have increased in number, which is one individual increase for prey and one individual for predators. This means that the stability of the ecosystem cycle will be maintained and stable, as seen from the same number of increases in each species. The margin number between the two populations remains the same compared to the initial values. This implies that the system is stable.

However, if the number of predators were greater, it could result in a reduction in the number of prey, and as a result that would have an impact on the number of plants, which can be increased or decreased, which in turn can disturb the stability of the ecosystem.

Future work

The numerical simulation above has made used of hypothetical data. It can be extended to apply to real data. This will be very helpful in maintaining the stability of an ecosystem, particularly in conserving any national park in the future or any other purpose related to sustaining biodiversity. Mathematical tools can play important role in solving complex problems in reallife.

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19. ORGANIC FARMING: SOLUTIONS TOWARDS FARMER ATTITUDES IN USING HIGH DOSAGE PESTICIDES

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Abstract

Climate change as contributed to by human activity is a problem that cannot be underestimated. Massive use of pesticides has been proved to affect climate change. At the global level, the agricultural sector contributes about 14% of total emissions in 2000, while at the national level the agricultural sector contributes 12% (51.20 million tons CO_{2e}) of the total CO_{2e} emissions. This research aims to describe the changes in farmers' attitudes towards the use of pesticides and how this might affect climate change. The participants of this research are farmers who have been working in the Alfa Omega Foundation for more than 20 years. The result of this research is that farmers found it more convenient to use an organic farming model: they are able to give large enough dosages of remedies for the plants, and to develop a healthier agriculture through organic farming, towards both the Earth and their bodies.

Keywords: climate change, farmer's attitude, organic farming, pesticides

Abstrak

Perubahan iklim sebagai akibat perilaku manusia menjadi masalah yang tak dapat disepelekan. Penggunaan pestisida kimia dalam jumlah yang besar terbukti mempengaruhi perubahan iklim. Di tingkat global, sektor pertanian menyumbang sekitar 14% dari total emisi, sedangkan di tingkat nasional sumbangan emisi sebesar 12% (51,20 juta ton CO2e) dari total emisi sebesar 436,90 juta ton CO2. Penelitian ini bertujuan untuk menggambarkan perubahan sikap petani terhadap penggunaan pestisida kimia dan bagaimana hal ini dapat mempengaruhi perubahan iklim. Partisipan dalam penelitian ini adalah 3 petani yang telah bekerja di Yayasan Alfa Omega selama lebih dari 20 tahun. Hasil dari penelitian ini adalah para petani merasa lebih nyaman menggunakan model pertanian organik, mereka mampu memberikan dosis obat yang cukup pada tanaman, dan mengembangkan pertanian yang lebih sehat dan lebih menjaga bumi dan tubuh mereka.

Keywords: perubahan iklim, sikap petani, pertanian organik, pestisida

Introduction

Farmers have attitudes and habits in relation to diseased or infertile plants: that is, the plants must be given pesticides. If this has been done and the plant has not recovered, the farmer thinks the solution is to increase the dose of the pesticides. They tend not to think about nutrition, sanitation, or other factors that affect the growth of these plants.

The attitude of the farmers is the attitude of the community at large. This comes from their mindset about medicines. For example, if they are sick, they must take medicine. If they have not recovered, they will take higher doses of the medicine without regard to diet, rest patterns, or the nutrients the body needs. They think that diseased plants are the same as their diseased bodies: that medicine with high doses is the best solution for the disease.

This is the same as Contemporary Cognitive Theory (from the 1980s) about human attitudes. A psychologist, James Baldwin (1897) states that there are at least two forms of imitation, one based on our habits and the other based on our insights on ourselves and on others whose attitudes we imitate. This theory views humans as subjects who actively receive, use, manipulate and transfer information.

Humans think actively, decide, solve problems, and make decisions. Humans process information in a certain way through cognitive structures that are given the term 'scheme' (Mustafa 2011). The scheme of the attitude of farmers in administering medicine to a diseased plant is an imitation of the attitude of the farmer when finding himself sick.

The Alfa Omega Foundation is a local NGO in Kupang Regency, East Nusa Tenggara Province*. It also focuses on processing in the agriculture sector. The Alfa Omega Foundation has 3 farmers who manage almost 2 hectares of agricultural land. Their change in the soil management model from the use of pesticides to the use of various organic materials is interesting to study. This is an effort to reduce the contribution of agricultural sector emissions which reach 14% at the global level and 12% at national level, as stated by Surmaini et al. (2011), related to the contribution of the agricultural sector in climate change. The observations will certainly be beneficial when the Alfa Omega Foundation wants to conduct training for farmers in the village. The Alfa Omega Foundation can show examples of good organic farming.

Approach

This research is a qualitative study using interview techniques. The informants are 3 farmers. They have worked in the Alfa Omega Foundation for more than 20 years. In the beginning, they used pesticides and chemical fertilisers on their plants. Now, for 2 years, they have been using various organic materials as disease treatments and as organic fertiliser. In other words, they have begun to develop organic farming models.

The purpose of this study was to describe how a mindset change can affect farmers' attitudes in agriculture and to understand how organic agriculture can positively affect farmers' attitudes about using pesticides. It is hoped that this research can be taken into consideration, or a trial set up, for comparison with the Alfa Omega Foundation, when talking to the community to build public awareness about climate change, biodiversity, and biosecurity.

Discussion

The farmer participants of this research have begun to develop organic farming models. Their attitudes to providing nutrition and medicine to plants are shifting. In the past, they used chemicals on plants, and now for 2 years they have used organic ingredients instead.

The benefit of developing an organic farming model is that the cultivated soil maintains its fertility for longer periods. Soil moisture is retained. Fresh fruits and vegetables are produced. With this agricultural model, the farmers can achieve good yields and large amounts of produce. Moreover, consumers feel more satisfied with the produce.

In addition, the farmers are avoiding various diseases caused by the use of pesticides. According to research results from Yuantari et al. (2015) ('The analysis of the risk of pesticide exposure to farmers' health'), it is known that the use of pesticides is very risky for farmers. When farmers spray pesticides, it is possible that the farmer's body is also exposed to pesticides. Parts of the body that are usually affected by pesticides include hands, feet, body, face, back, and even eyes. If this is allowed to continue, it can cause chronic illness (Yuantari et al. 2015).

The farmers interviewed acknowledged this. The possibility of their bodies being exposed to pesticides is very large because they do not use safe body protection while working, such as gloves, masks, and so on. They also realise that the health benefits of not using chemical pesticides are felt not only by them but also by consumers. Consumers no longer consume foods that contain chemicals.

To summarise, farmers realise that the organic farming model is a solution to the problem of using pesticides on plants. They can get satisfactory crops without destroying soil fertility. They can also be involved in protecting the agricultural environment by reducing the use of agricultural materials that will have an impact on climate change.

* https://yaokupang.id. Alfa Omega: YAYASAN PELAYANAN DAN PENGEMBANGAN MASYARAKAT – GMIT

Future work

a. Conducting research on Alfa Omega agricultural land to restore soil and soil fertility: this is possible by building partnerships with several research institutes.

b. Alfa Omega Foundation builds cooperation with grassroots communities, by approaching stakeholders to build public awareness about the dangers of using pesticides and the importance of changing the attitudes of farmers in using pesticides on plants.

c. Alfa Omega Foundation provides real examples of organic agricultural yields and the benefits of organic farming processing.

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Above and below: Plants growing on Alfa Omega Foundation land.

20. MIRACLE IN TIMOR ISLAND

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Abstract

The moringa tree can play an important role in soil and water conservation and thereby help to mitigate climate change. Moringa (*Moringa oleifera*) is a tree that is sometimes called a 'Miracle Tree' because all of its parts are used for nutritional and pharmacological purposes (Daba 2016). It is a plant that lives naturally and is widely distributed in the dryland of Timor Island. For this reason, it is called 'miracle' in Timor Island. In the past, this land also grew sandalwood, sorghum, soe orange and soe apple which were popular, well-known, high quality plants with large populations. However, they are almost extinct these days. Will moringa have the same fate as those plants? This case study provides a brief review of causes of these previous extinctions, and potential solutions.

Keywords: moringa, *Moringa oleifera*, miracle, dryland, extinct

Abstrak

Pohon kelor (Moringa) dapat memainkan peranan penting dalam konservasi lahan dan membantu mitigasi perubahan iklim. Moringa (*Moringa oleifera*) adalah jenis pohon yang dapat disebut "Pohon Ajaib" karena semua bagiannya dapat digunakan, baik untuk nutrisi dan farmakologi. Moringa merupakan salah satu tumbuhan yang hidup alami dan tersebar banyak di tanah kering Pulau Timor. Ini merupakan suatu keajaiban di Pulau Timor. Pulau timor juga memiliki cendana, sorgum, jeruk soe dan apel soe yang popular, terkenal dan banyak pada masa dahulu tetapi mereka hampir punah saat ini. Akan kah moringa memiliki nasib yang sama? Studi kasus ini memberikan tinjauan penyebab kepunahan spesies ini di Tanah Timor dan solusinya.

Kata kunci: moringa, *Moringa oleifera*, keajaiban, lahan kering, kepunahan

Introduction

Extinction (of species) is caused by failure to adapt to change in the environment. Major causes can include habitat destruction, changes in climate or sea levels, and collision with the Earth by asteroids or meteorites.

Moringa is a very valuable food crop: it is highly nutritious, grows very fast and is drought resistant (Daba 2016). It is an easy plant to grow and it is not extinct today, just as sandalwood, sorghum, soe orange and soe apple were not extinct in the past. They are now almost extinct, and that situation has an impact on the food security, economy and also the local biodiversity of Timor Island, Indonesia. A study needs to be done to understand how these plants have become almost extinct in their original natural habitats. Possibly such a study can prevent the extinction of other species, such as moringa, flores coffee, etc. In addition, it may show how those threatened species can be re-cultivated in Timor Island.

Moringa grows back even though it has been cut down in summer.


Cleaning citrus plants from pests by cutting infected leaves & twigs and spraying pesticides.

Approach

As a farmer, I often hear complaints and glorious stories of these plants in the past. I am interested to know why they are at risk of extinction. It is a mystery and also a miracle. For this study I observed in the field and interviewed 5 farmers and 15 agriculture instructors. The results are compared with information from a literature study, to find causes of these previous near-extinctions and potential solutions.

Result and discussion

Based on information gathered in 1987/1988 – 1997/1998, the production of **cendana** (*Santalum album* L.) decreased by 53.95% because of high logging, high theft, and disruption by fire and livestock, which were out of balance with the amount of successful regeneration (Surata 1999). A policy, Perda No. 16, was issued in 1986, but application of this regulation is still having relatively little effect in contributing to sustainability (Surata & Idris 2001).

The main diseases that infect **sorghum** (*Sorghum bicolor* L.) in Timur Tengah Utara are stem rot caused by *Rhizoctonia* sp., rust disease and leaf blight caused by *Helmithosporium* sp. (Rusae et al. 2018). The farmers said that sorghum has been replaced by rice. In addition, the farmers do not know about sorghum's benefits, how to grow it, pest control, its economic value and its post-harvest management.

It is reported that stem rot disease and *Diplodia* fungus has spread widely in **soe orange** (*Citrus reticulata* Blanco) production centres (Suek et al. 1998). The extinction of soe orange, therefore, was not due to climate change but instead a result of the diseases *Phytophthora*, *Diplodia* and citrus vein phloem degeneration (CVPD). The pathogens associated with CVPD, especially, are commonly found since applying chemical fertilisers (Salukh 2019). Prevention and eradication of these pests and diseases are not thorough; farmers are becoming less serious about soe orange farming. In interviews, farmers and agriculture instructors stated that climate change can reduce the amounts and sizes of leaves, flowers and fruit.

Research information about **soe apple** is very difficult to find. The interviews revealed that apples have suffered from the same factors that are leading to orange extinction. According to the Balitjestro website (Balitjestro 2015), NTT (East Nusa Tenggara) has potential land for apple crop development but it does not yet have an apple production centre, although one was expected, because its development has not been followed by an understanding and application of best practice of apple cultivation technology.

The **moringa tree** still has enormous potential to be fully explored for its health-related benefits and for food processing (Daba 2016). The most common pest in the field is a caterpillar in the order Lepidoptera. The disease that mostly attacks moringa plants in the field is the fungus *Ganoderma* (Akbar 2018). The farmers said that moringa is difficult to grow on agricultural land that has little soil organic matter, and that information on moringa cultivation suggests applying chemical fertiliser even though it does not need it.

Future work

Approaches that provide information about the economic value of the local plants, together with provision of food processing, promotion and market access, can be used to bring these plants to the attention of the farming community. The causes of previous plant extinctions in Timor Island can be remedied by applying knowledge of dryland agriculture, post-harvest management, economic management, stakeholder awareness, technology, pest/disease control, financial responsibilities/support, legislative provisions, surveillance and on-farm biosecurity practices. Local farmers need the support and collaboration of the community, agriculture department, educational institutions, industry, government and the private sector. They should introduce training and information to explain the importance of biodiversity, biosecurity and food security concepts for dryland farmers.

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PLANT ECOSYSTEM AND PLANT GENETIC DIVERSITY, AND OTHER RELATED FIELDS

21. ***Ni Putu Yuni Astriani Dewi***
    Case study: Conservation of orchids in East Central North District

22. ***Olasri Maboy***
    Climate change mitigation: the case of East Nusa Tenggara sandalwood

23. ***Komang Dean Ananda***
    Analysis of mangrove vegetation as part of efforts to preserve the mangrove ecosystem in Tahura Ngurah Rai

24. ***Emilia Juliyanti Bria & Remigius Binsasi***
    Diversity of plants for building with plant material: ethnic Dawan traditional houses in North Central Timor Regency

21. CASE STUDY: CONSERVATION OF ORCHIDS IN EAST CENTRAL NORTH DISTRICT

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Abstract

The orchid family of plants has very high diversity, but information about their distribution and ecological character is still very limited, especially in some conservation areas. One way to determine the richness of orchid species in an area is to inventory and identify them in their natural habitats. This research aims to conduct an inventory of orchid species around East Central North District, to find out types of orchids and host trees. The results are expected to be material for scientific information about biodiversity, for use by relevant agencies and the general public.

Keywords: orchids, conservation, biodiversity

Abstrak

Anggrek merupakan salah satu jenis tumbuhan yang memiliki keanekaragaman sangat tinggi. Namun saat ini, informasi mengenai distribusi dan karakter ekologis khususnya di beberapa daerah konservasi masih sangat terbatas. Salah satu upaya yang dapat dilakukan untuk mengetahui kekayaan jenis anggrek di suatu kawasan adalah dengan menginventarisasi dan mengidentifikasi jenis anggrek di habitat alaminya. Berdasarkan itu, maka penting untuk melakukan penelitian mengenai identifikasi maupun inventarisasi jenis anggrek khususnya di sekitar Kabupaten Timor Tengah Utara. Tujuan dilakukannya untuk mengetahui jenis-jenis anggrek dan pohon inangnya. Hasil diharapkan dapat menjadi bahan informasi ilmiah tentang biodiversitas kepada masyarakat luas tentang jenis-jenis anggrek yang ada di sekitar Kabupaten Timor Tengah Utara.

Kata kunci: anggrek, konservasi, biodiversitas

Introduction

Some types of orchids have experienced a population decline, caused by uncontrolled exploitation of the orchids and destruction of habitat because of forest fires and landslides (Lisnandar et al. 2012). Putting new roads through orchids' natural habitats is also a cause of population decline, including of species of *Dendrobium*.

Propagation of species of *Dendrobium* has become very important because the conditions in its natural habitat no longer support orchids. One method for conserving *Dendrobium* species is to conduct mass propagation in the laboratory (conservation *in situ*), using tissue culture techniques (Figure 1).

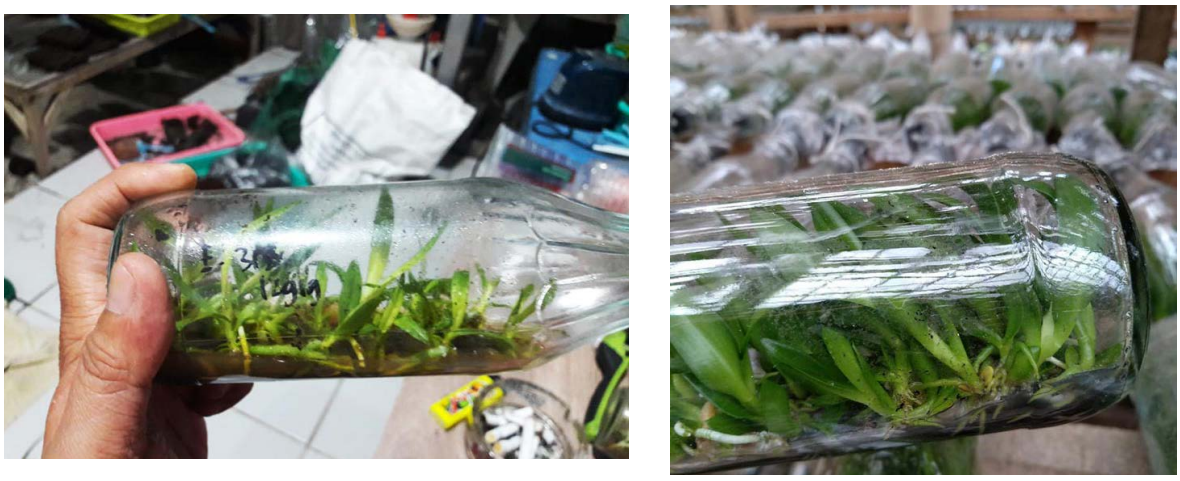

Figure 1. Tissue culture of orchids.

Conservation of orchids can also be achieved by saving seeds. Orchid seeds are usually difficult to germinate naturally. This is due to the fact the orchid seeds do not have endosperm. Endosperm has an important role in the initial process of germination. Endosperm has a function as a storage of food reserves in seeds (Warseno et al. 2013).

It is well known that orchids are widely used as ornamental plants. Besides that use, however, there is some information that several types of orchid can be used as herbal medicines. For example, *Dendrobium crumenatum* is commonly used as medicine, including as acne medicine, earache medicine, cholera medicine, and even medicine to restore brain damage.

Research on the diversity of orchid species, especially in the NTT region (that is, Nusa Tenggara Timur, or East Nusa Tengarra) and in the North Central Timor regency, has not been conducted previously.

Approach and outcomes

The first step in identifying the types of orchids in the TTU district (Central North Timur District) is to approach the local community. The local community can be contacted and interviewed. The interview method should involve both the traditional leader and the local community who plant orchid species in their home yards.

In addition, information can be obtained through the literature, including the characteristics of the study site, geographical location, and condition of the forest in the study location.

Figure 2. Flowers of a *Dendrobium* species of orchid found in a home yard in a local community. These orchids attach themselves to trees (as host) and usually obtain nutrients and shade from their host tree.

In casual observations, several types of orchid have been found around the town Kefamenanu. For the most part, orchid species are planted around home yards. Based on morphological characteristics, the orchid found is *Dendrobium*, but to identify the plants to species level, further investigation is needed: for example, through asking the local communities for information.

Discussion

Dendrobium is a genus of orchids favoured by orchid lovers. This is because this orchid is able to adapt to various environmental conditions to grow. In addition, *Dendrobium* can live in direct

sunlight with no shade from other plants, and during the winter *Dendrobium* requires very little water. Some *Dendrobium* orchids can live in dry areas: these orchids usually live attached to a large tree (host).

Some *Dendrobium* species are epiphytic orchids that grow naturally in southern Asia, namely Thailand, India, Sri Lanka, Laos, Vietnam, Philippines, Malaysia, Indonesia and Papua New Guinea (Tuhuteru et al. 2012). In their natural habitats these species are beneficial, preserving the natural balance of the ecosystem in the forest as a place of life and other organisms. They are ornamental plants and are used by plant breeders as parents in crossbreeding to produce individuals with new variations.

Future Work

An approach must be made to the local community regarding the existence of orchid species in their natural habitat. The objective is to obtain preliminary information so as to identify and inventory orchid species in the TTU District. In addition, this case study will contribute to conservation and preservation of orchid biodiversity through embryo-rescue.

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22. CLIMATE CHANGE MITIGATION: THE CASE OF EAST NUSA TENGGARA SANDALWOOD

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Abstract

Climate change is inevitable and has become one of the most serious global problems to be tackled. The impacts of climate change are calamitous especially in dryland areas, causing, *inter alia*, severe drought, economic disadvantage and biodiversity loss. This paper proposes that the NTT Government could fast track re-introduction of the cultivation of sandalwood as one solution towards climate change mitigation. The premise for this is environmental and economic benefits. Past and current regulations and policies can be utilised. Moreover, there is need to highlight the importance of disseminating information, cooperative action and good communication at all levels.

Keywords: climate change, dryland, sandalwood, policy

Abstrak

Perubahan iklim tidak terhindarkan dan telah menjadi salah satu masalah global yang harus ditangani. Dampak dari perubahan iklim sangat berbahaya khususnya yang terjadi di lahan kering seperti kemarau berkepanjangan, kerugian ekonomi dan kehilangan keanekaragaman hayati. Tulisan ini mengusulkan ke pemerintah NTT untuk lebih gencar mencanangkan penanaman kayu cendana sebagai salah satu solusi untuk menangani perubahan iklim karena dapat meningkatkan ekonomi masyarakat dan pada saat yang sama memelihara lingkungan. Peraturan-peraturan dan kebijakan-kebijakan terbaru dan masa lalu akan dikaji. Selanjutnya, tulisan ini menyoroti pentingnya sosialisasi ke masyarakat, kerja sama dan komunikasi aktif dari semua pihak.

Kata Kunci: perubahan iklim, lahan kering, kayu cendana, kebijakan

Introduction

Climate change has become one of the world's most urgent conundrums to be addressed. The impacts of climate change are calamitous.[1] The United Nations says impacts include higher temperatures, melting glaciers, severe droughts, worsening biodiversity such as plants needing to grow in more difficult environments, and economic loss.[2] Accordingly, these downside effects of climate change require policies that are multi-faceted, and demand holistic action: for example, incorporating climate change adaptation and risk reduction plans into regional and national strategies.[3]

To mitigate climate change in dryland areas such as NTT (East Nusa Tenggara) is particularly challenging. Essentially, one must understand the comparative benefits of dryland. Accordingly, it is important to develop various agricultural commodities such as food crops and plantations, and to conserve endemic plants that suit the land's topography. An example of these is sandalwood, owing to its economic and environment benefits.[4]

Sandalwood has these strengths: (1) the NTT region is a natural habitat for sandalwood; (2) there is strong Government commitment, as outlined in the NTT program as the 'Sandalwood Province'; (3) extensive community-owned land can be used for the development of sandalwood cultivation. Also, sandalwood opportunities are in high demand in the market because sandalwood is one of the most expensive woods in the world; and sandalwood has characteristics that allow it to be intercropped with other plants.[5]

Approach

Here is the proposed method to fast track the re-introduction of sandalwood cultivation.

The first suggestion to the Government to adopt this would be to compile policy and regulatory reforms in sandalwood management. This is vital because the Government needs to restore public trust – given the history of sandalwood regulation that once did not favour the community (over-exploitation, amelioration of property rights, government abuse of power).[6]

Furthermore, the Government must disseminate information about changes in regulations on sandalwood management. This is crucial, especially because there are still many people affected by the NTT Government Regulation, Perda No. 16 of the year 1986.[7] This Perda emphasised the Government's claim over all sandalwood trees that grew in NTT via cultivation and natural growing: in the national forest land, and in individuals' and corporations' land. The Government exclusively possesses the solitary rights to sell and keep 85% of the revenue. In its new Perda No. 86 of the year 1996, although the Government increased the individual dividend to 40%, the cutting of sandalwood without Government permission consequently placed the doer in jail. However, today this Perda has been revoked and state monopsony has been ceased. Thus, it is expected that wide communication will significantly assist to ameliorate this misunderstanding.

Moreover, the Government should become the first party that actively cultivates sandalwood. This can be done by planting sandalwood on the widely available non-productive public and national forest land. Currently, the NTT Government has planted sandalwood on 5 ha in Silu, Kupang Regency. In parallel, the Government should involve the community because 80% of the NTT sandalwood derives from private rather than national forest land.[8] The actions taken should include providing high-quality seedlings and advising farmers on how to produce seedlings traditionally.

In addition, there must be extensive market deregulation pertaining to pricing and marketing channels. In principle, the marketing of sandalwood products is carried out for increasing the added value of sandalwood. This also means that the Government only takes its proportion in the form of moderate tax.

Discussion

To ensure Garrett Hardin's 'tragedy of the commons' principle is avoided (Hardin 1968), the Government of Indonesia has seriously proved its commitment by enacting many regulations, and making policies to maintain biodiversity. For example, the ratification of the Paris Agreement on Climate Change Convention 2016; the establishment of the 2015 Directorate General of Climate Change Control; and compulsory conduct of environmental impacts assessment.[9]

It should be remembered that people of NTT once boasted of sandalwood.[10] However, sandalwood has become less available and it is fair to say that it is gradually becoming extinct.[11] The main reasons making sandalwood fail to become successful again are not solely that there is less rain, with the rainy season in NTT annually starting in late November and or/early December and finishing in March,[12] but also the 'wrong' policy decisions of the past. The law, thus, needs to calibrate its remedies according to the severity of the biological threat. New policies need to be supported by recent data, such as the availability of national forest lands and the proportions of total sandalwood plants that are planted and survive.[13] Eventually, the policies will support future management of biodiversity and biosecurity issues that can eliminate climate change.

It is noted that sandalwood in NTT has been an example of natural resource destruction with little or no regard for long-term management and ecological sustainability.[14] In other words, it has suffered from the destructive combination of long-term ill-conceived policies and interference, and short-term economic opportunism. This is because a long time ago political power holders were well placed to monopolise available sandalwood stocks. Although subsequent regulations imposed a moratorium on the extraction and export of the sandalwood, the conservation of remaining stock is sluggish.[15]

Sandalwood is a beneficial species for tackling issues raised by climate change. It decreases CO_2 in the atmosphere and diminishes warming by lessening sun reflection (albedo) on otherwise strongly reflecting and heating dryland. Sandalwood is a great fit for dryland, and through its growth it mitigates floods and loss of soil, both of which are happening increasingly during climate change.

Furthermore, sandalwood has high economic value because of the essential oils within its stems and roots.[16] It is recorded that within the period 1980–2000, commercial sandalwood production reached 15,000 tonnes. Sandalwood even contributed 28.20 – 47.60% of local government revenue.[17]

Future work

Enacting the proposed policy and regulatory changes will not only bring environmental benefits but also, more importantly, economic welfare both for citizens (e.g. as a source of income or employment opportunity) and for the state (e.g. by tax derivation, less unemployment or better land conditions). If those benefits are aligned, they are highly likely to achieve success as they incentivise actions which are in both the public and the private interest – a win-win situation. The side-effects of sandalwood growing, e.g. fewer floods and/or less loss of soil would improve living conditions as well.

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23. ANALYSIS OF MANGROVE VEGETATION AS PART OF EFFORTS TO PRESERVE THE MANGROVE ECOSYSTEM IN TAHURA NGURAH RAI

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Abstract

The purpose of this study was to analyse the mangrove vegetation in Tahura Ngurah Rai, Bali Island, Indonesia, in order to find out the structure of the mangrove community. We used the line transect method, where vegetation data are collected and analysed to determine the structure of mangrove plant communities in detail. Our data revealed three plant species with a high Important Value Index (IVI): *Sonneratia alba* (188.85), *Rhizophora apiculata* (74.64), and *Rhizophora mucronata* (25.44). Monitoring the mangrove ecosystem for diversity is important to evaluate the health of these systems over time. In Tahura Ngurah Rai, mangrove has a Diversity Index (H') indicating low diversity, while the value of the Evenness Index (e) indicates medium evenness.

Keywords: mangrove, vegetation analysis, environmental preservation, biodiversity

Abstrak

Tujuan dari penelitian ini adalah untuk menganalisis vegetasi mangrove di Tahura Ngurah Rai, Bali, Indonesia, dalam rangka mengetahui struktur komunitas ekosistem hutan mangrove. Metode yang digunakan adalah metode transek garis, dimana data vegetasi dikumpulkan dan dianalisis adalah untuk menentukan struktur komunitas secara rinci. Dari data yang kami peroleh, terdapat tiga spesies mangrove dengan Indeks Nilai Penting (INP) tertinggi; *Sonneratia alba* (188,85), *Rhizophora apiculata* (74,64), dan *Rhizophora mucronata* (25,44). Indeks Keanekaragaman pada ekosistem mangrove dapat menjadi acuan untuk mengevaluasi stabilitas sistem di dalam ekologi mangrove itu sendiri dari waktu ke waktu. Di Tahura Ngurah Rai, mangrove memiliki Indeks Keanekaragaman (H') yang termasuk dalam kriteria rendah, sedangkan Indeks Kemerataan / Evennes Index (e) termasuk dalam kriteria sedang.

Kata kunci: mangrove, analisis vegetasi, pelestarian lingkungan, biodiversitas

Introduction

It is important to consider biodiversity, because the condition of biodiversity is the key to environmental balance. The categories of biodiversity are: genetic diversity, species diversity, and ecosystem diversity (Primack 2004). Indonesia is a megabiodiverse country. Moreover, Indonesia is an archipelago that has many coastal areas. Mangroves are part of biodiversity in coastal areas. Mangroves can absorb and store carbon and reduce greenhouse gas emissions. Indonesia has the largest mangrove forest in the world. The area of mangroves in Indonesia is still* estimated at 23% of total global mangroves (Spalding et al. 1997).

The existence of mangroves in the tidal zone makes mangroves the receiving sites for various wastes from the mainland and territorial waters. Mangrove forest has several functions (Kustanti 2011): (1) biological/ecological function, such as food provider for mangrove fauna (shrimp, crab, fish, bird and mammal); and mangroves are shelter, gathering and hiding places for juveniles, and an ideal place for marine biota for spawning; (2) physical functions, protecting the beach from big waves, strong winds and storms; and mangroves retain sludge and trap sediment, prevent sea water intrusion, and accommodate natural organic waste processes; (3) social and economic function, when the community is involved in mangrove forest management. Based on these functions, mangroves have an important role in maintaining biodiversity in the surrounding area in addition to the mangrove itself also being part of biodiversity.

* see https://ppid.menlhk.go.id/siaran_pers/browse/561

In Bali, there are a number of mangrove areas, one of which is Tahura Ngurah Rai. Mangrove Tahura Ngurah Rai is located in South Bali as an industrial area, supporting tourism, offices, and residential. Development related to these functions has led to changes in the mangrove area. This can disturb the stability of the mangrove forest ecosystem in Tahura Ngurah Rai. Thus, it is necessary to investigate the mangrove community structure in Tahura Ngurah Rai, to see if those mangroves are still fulfilling their function, biologically/ecologically, physically, socially and economically.

Approach

The data were collected using vegetation analysis by line transect method, to get an overview of the diversity of species making up the mangrove stands, and their density, frequency and dominance. This will reveal the degree of degradation of the mangrove ecosystem in Tahura Ngurah Rai. The data collection begins with digitisation of an Earth map, related to the conditions at the study site. From the digitisation, a base map is made as a working map. Furthermore, the digitisation of the Earth map is used as a reference for direct checks on the research sites. The samples are planned on the work map by drawing a line transect and then they are measured and observed at the research location. There are 10 sampling points (Figure 1).

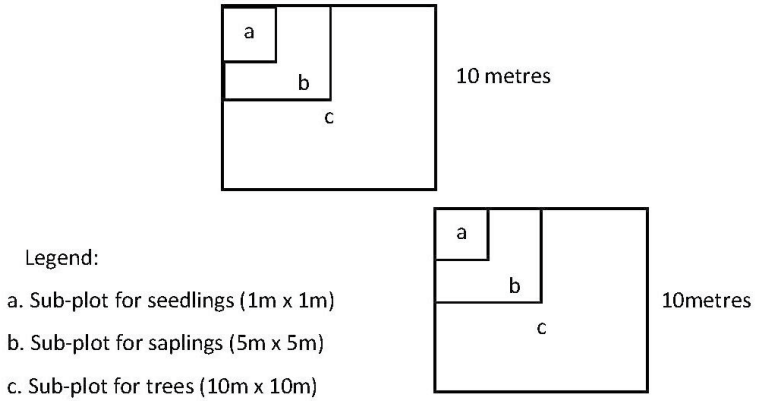


Figure 1. Line Transect Plot

Discussion

Based on the analysis of vegetation, the three species with highest Important Value Index (IVI) were *Sonneratia alba*, *Rhizophora apiculata*, and *Rhizophora mucronata* (Table 1). The IVI shows the importance of a plant species and its role in the community. In this case, *Sonneratia alba* is the species that gives the greatest contribution to its community, and it is responsible for the stability of the community that builds ecological relations between species in Tahura Ngurah Rai.

Information about the structure and stability of the community can be obtained by measuring the Diversity index (Shannon–Wiener Index) and the Evenness index (Figure 2). Monitoring the mangrove ecosystem for diversity is important for evaluating the health of these systems over time. The diversity of species in each region can be indicated by the Diversity Index (H'), while the evenness of species in each region is indicated by the Evenness Index (e).

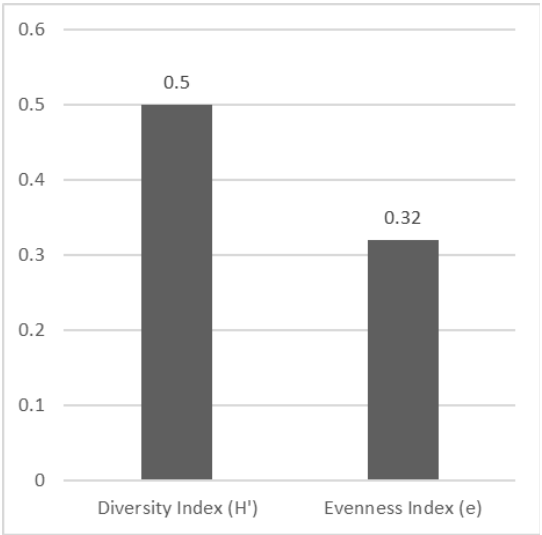
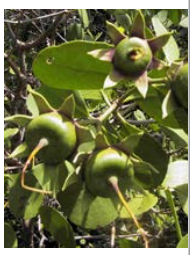


Figure 2. Diversity Index (H') and Evenness Index (e) in Mangrove Tahura Ngurah Rai

Table 1. Important Value Index (IVI) in Mangrove Tahura Ngurah Rai

Species	Local Name	Family	IVI	Rank	Picture
Sonneratia alba	prapat	Sonneratiaceae	188.85	1	
Rhizophora apiculata	jangkah	Rhizophoraceae	74.64	2	
Rhizophora mucronata	bakau	Rhizophoraceae	25.44	3	

According to Giliba et al. (2011) the index value of species diversity indicates species richness (number of species) and species distribution in a region. The higher value of H' means the higher variation of the species and their distribution in a vegetation. Diversity of species is classified as high if $H' > 3$, classified as moderate if $1 \leq H' \leq 3$, and classified as low if $H' < 1$ (Fachrul 2007). Meanwhile, evenness of species is classified as high if $e > 0.6$, classified as moderate if e is between 0.3 and 0.6 and classified as low if $e < 0.3$ (Barbour 1987).

High species diversity in an ecosystem describes a stable ecosystem that has a good energy flow, because it is able to support the survival of abundant species. Each species has a different tolerance and a different life cycle; thus high species diversity indicates a good and well-established ecosystem. Mangrove vegetation in Tahura Ngurah Rai has a value of H' (= 0.5) which indicates low diversity, while the value of e (= 0.32) indicates moderate evenness (Figure 2).

The H' value and the e value, which are not in the high range for these criteria, probably result from the impacts of various human activities, especially those in the South Bali region. The continued development efforts have an impact on the existence of the mangrove ecosystem in Tahura Ngurah Rai. All stakeholders should participate in development planning based on environmental sustainability, especially in maintaining the sustainability of the mangrove ecosystem in Tahura Ngurah Rai.

Future work

The current condition of the mangrove ecosystem in Tahura Ngurah Rai can be a reference point for designing the management of mangrove areas in the future. Knowing the structure of the plant community in detail will show the condition that is being experienced by the mangrove ecosystem itself. To maintain a mangrove forest ecosystem is not an easy thing, but it is possible to do. There needs to be coordination and integration between various stakeholders, especially the government, the private sector, and the community.

The mangrove forest ecosystem must be able to function optimally and develop its potential. If the ecosystem can perform its biological/ecological function and its physical function optimally, then it has social and economic value for ecotourism and for non-timber forest products, and marketing its products can be locally important. Preserving mangroves can work towards maintaining biodiversity, especially in the coastal areas of South Bali.

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24. DIVERSITY OF PLANTS FOR BUILDING WITH PLANT MATERIAL: ETHNIC DAWAN TRADITIONAL HOUSES IN NORTH CENTRAL TIMOR REGENCY

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Abstract

In traditional communities local wisdom about environmental management is passed down through the generations from parents to offspring. Current changes in society and technologies are eroding traditional knowledge about building materials and construction methods based on local materials. Within the Dawan Ethnic group in North Central Timor Regency we sought to document the methods of building houses in their traditional style, and to investigate the local building materials used. We found that there are seven species that provide wood (*Pterocarpus indicus* and *Tectona grandis*), rope (*Entada phaseoloides*) and roof (*Arenga pinnata*, *Areca catechu*, *Calamus*, and *Imperata cylindrica*). Our findings indicate that many different plant species traditionally used for construction need to be sustained in order for these traditional building methods to be conserved over time.

Keywords: traditional house, ethnic Dawan, diversity, material building

Abstrak

Dalam komunitas tradisional, kearifan lokal diturunkan dari generasi ke generasi. Perubahan masyarakat dan teknologi saat ini mengikis pengetahuan tradisional tentang bahan bangunan dan metode konstruksi berdasarkan bahan lokal. Upaya untuk mendokumentasikan metode membangun rumah tradisional dilakukan dalam Etnis Dawan di Kabupaten Timor Tengah Utara. Selain itu, kami juga menginventarisasi bahan bangunan lokal yang digunakan. Hasil penelitian ini menunjukkan bahwa ada delapan spesies yang terdiri dari kayu (*Pterocarpus indicus* dan *Tectona grandis*), tali (*Entada phaseoloides*) dan atap (*Arenga pinnata*, *Areca catechu*, *Calamus*, dan *Imperata cylindrica*). Hal ini menunjukkan bahwa banyak spesies tanaman berbeda yang secara tradisional digunakan untuk konstruksi bangunan perlu dilestarikan agar metode bangunan tradisional ini dilestarikan dari waktu ke waktu.

Kata kunci: rumah tradisional, etnis Dawan, keanekaragaman, bahan bangunan

Introduction

The presence of plant species in a location depends on climate, topography, soil conditions and land use. Climate and topography determine temperature and rainfall, modified by a site's elevation and aspect, especially for mountain slopes and mountains. The condition of the soil also affects the types of plants that can exist in a location (Simamora et al. 2017). However, the type of land use, which is a combination of natural and human factors, determines the actual plant species in a location and also the ways in which the community uses and processes them.

Timor Island, one of the islands of East Nusa Tenggara, has a dry season that lasts longer than its rainy season. The island is subject to wet monsoon winds during November–April and these, along with the island's location closer to Australia than Asia, have an impact on the plant species that are adapted to these conditions (Mundita 2013).

Traditional houses (e.g. Figure 1), that are called 'lopo' in Dawan Ethnic in North Central Timor Regency, have always relied on local wisdom for their building techniques and materials. The community uses a lot of natural materials to build the traditional houses. However, this situation has been changing over time. The community now replaces natural materials with modern materials which are obtained in the market and easy to use.

This study aims to examine the diversity of plants that are used to build the traditional house of the Dawan Ethnic in North Central Timor Regency.

Figure 1. Lopo building and its construction in Tamkesi Village, North Central Timor Regency.

Approach & outcomes

This research was conducted in August 2019 in Tamkesi Village, one of the customary villages in North Timor Regency. This study used an ethnobotanical approach: that is, interviews with key informants, observation, and documentation techniques (Awalia et al. 2014). This study's purpose is to identify the plant species related to traditional building materials in Dawan ethnic knowledge, and to achieve a better understanding of species diversity within the areas under investigation and the sustainability of using plant-based building materials.

Discussion

Lopo is a building without walls. It is located in front of the living house and is usually used as a barn and recreation area and meeting place (Figure 1). Furthermore, it is a symbol of the role of men as protectors of the inhabitants of the house (Karwur et al. 2016). In this study we found seven plant species that local people use as building material (Table 1). They provide the wood, rope and roof. These species used to be taken from the forest, but they are now very rare.

The abundance of the plants formerly used for building has reduced over time, under the influence of abiotic environmental factors and human activities. According to the local people, the area where the building materials grow has been converted to agricultural land, irrigation areas and residential areas. Besides that, the dry environment affects the growth of these plants, especially the growth period of the wood species which is very long. This factor has a large impact on the long-term existence of the plants.

Table 1. Plant materials used in traditional buildings in Tamkesi Village, North Central Timor Regency

No.	Species	Common name/local name	Family	Part used/part of building
1	*Pterocarpus indicus* Willd.	Kayu merah/Matani	Fabaceae	Wood/main pillar
2	*Arenga pinnata* (Wurmb) Merr.	Aren/Enau	Arecaceae	Wood/circular roof truss
3	*Tectona grandis* L.f.	Jati	Lamiaceae	Wood/ upright roof truss
4	*Areca catechu* L.	Pinang/Puah	Arecaceae	Wood/circular roof truss
5	*Entada phaseoloide*s (L.) Merr.	Gandu/bendoh/Fa'ek	Fabaceae	Tendril stem/binder/rope
6	*Calamus* sp.	Rotan	Arecaceae	Tendril stem/circular roof truss
7	*Imperata cylindrica* (L.) Raeusch	Alang-alang	Poaceae	Roof

Future work

Local wisdom is one of the traditional values that should be preserved. Therefore, conservation of plant species as building materials also needs to occur, along with community education to assist in understanding how to sustainably use the building materials. The next thing that needs to be done is to examine the effect of the environment on these plants' growth, especially those that provide wood. All information should be integrated into a geographic information system so that the information can be used effectively for various purposes including policy, tactical and operational.

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INDEX of keywords and others, **by paper number**

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