Original Article

Experiences and aspirations of seaweed farmers in Palawan, Philippines

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Received: 06 Feb. 2023 || Revised: 08 Sep. 2023 || Accepted: 03 Jan. 2024

ISSN: 1656-4707
E-ISSN: 2467-5903
Homepage: www.palawanscientist.org

How to cite:
San Juan RG, Madarcos JRV, Creencia LA and Galon FD. 2023. Experiences and aspirations of seaweed farmers in Palawan, Philippines. The Palawan Scientist, 16(1): 15-27. https://doi.org/10.69721/TPS.J.2024.16.1.03

ABSTRACT

Many coastal dwellers engage in seaweed farming despite of various challenges because of its simple farming technology, low capital investment, and short cultivation period. This paper explored the attitudes of seaweed farmers (n = 187) from nine coastal communities of Aborlan, Puerto Princesa, Roxas, and Taytay, Palawan towards the difficulties and challenges they experienced. The farmers' experiences in seaweed farming, mid-term aspirations, and factors affecting their positive attitudes towards seaweed farming were gathered using a Likert-scale questionnaire in KoBoToolbox. Focused group discussion (FGD) sessions were also conducted to obtain more data about their optimistic attitudes. Participants are 55% male and 45% female. Results revealed that farmers had a high level of optimism toward seaweed farming. The majority (75%) 'will continue to engage in planning the next cropping cycle', most (89%) 'are expecting to have a good harvest', and almost all (96%) 'are planning to generate raw dried seaweeds from their harvest.' Many (59%) of the respondents obtained high earnings from seaweed farming, but most (93%) experienced economic losses. As recovery options, 92% aspired to culture other organisms such as sea cucumber and abalone. Further, most of them wanted to seek assistance from government offices (91%), participate in seaweed product development (86.5%), and join a cooperative (87.5%). This study could serve as baseline information in designing relevant training and educational activities to assist seaweed farmers in managing their farms sustainably. Subsequently, this could aid in formulating effective policies to address similar problems of seaweed farmers in other municipalities of Palawan.

Keywords: attitude, cooperative, cropping cycle, diseases, diversity, farming technology

INTRODUCTION

Seaweeds have been utilized for wide applications such as food for human consumption and as an important hydrocolloid (alginate and carrageenan) that are used in food processing, pharmaceutical, and cosmetic industries (Hurtado et al. 2015). It is also an important livelihood among coastal communities (Mundo et al. 2002). Aside from its economic value and food for human consumption, seaweeds also provide other ecological services and have been included as one of the priority commodities under the World Bank-assisted Philippine Rural Development Project (PRDP) (BFAR 2022). Recently, its potential as a carbon sequester to mitigate ocean acidification (Xiao et al. 2021) and prevent eutrophic algal bloom (Narvarte et al. 2022), has been considered ecosystem services that seaweed farming may offer. Seaweed (Eucheumatid) farming was established in the Philippines in 1969 in Tawi-Tawi (Trono 1990), utilizing the indigenous cultivars of *Kappaphycus* ('cottonii') (Hurtado et al. 2015) and later named *Kappaphycus alvarezii* in honor of Vicente Alvarez, the General Manager of Marine Colloids Philippines, Inc. (MCPI) (Neish et al. 2017). Initial experimental farming sites included Panagatan Island, Caluya, Antique, and Ilin Island, Occidental Mindoro. However, these farming sites were later abandoned due to frequent typhoons and management problems. In Sulu, better growth was obtained in 1971 and had driven the cultivation in other areas (Hurtado et al. 2015). In Palawan, Eucheumatid seaweed farming started in Quinloban Island, Agutaya as part of the satellite cultivation conducted by MCPI in 1973. The first commercial seaweed farming was set up in Green Island, Roxas, in 1978 with the initiatives of MCPI. However, the take-off of Eucheumatid seaweed farming in the province started utilizing the Tawi-tawi seaweed culture technology in Balabac. Since then, farming has been replicated in other areas, resulting in widespread cultivation through out the province and about 138,950 t annual production from the 20 seaweed-producing municipalities, Palawan is the second largest producer of seaweeds in the country; it contributes significantly to the export market as an aquaculture product. In 2020, Palawan produced 317,830 mt of seaweed, contributing 22% to national seaweed production (BFAR 2022). Overall, this industry contributes about 60-70% to the country's total aquaculture production and improves the socioeconomic status of millions of Filipinos (BFAR 2022; Pedrosa 2017).

On a global scenario, the Philippines ranked fourth (1.49 million metric ton or Mmt) in the major seaweed-producing countries, with China as ranked number one (20.1 Mmt), followed by Indonesia (9.9 Mmt), and South Korea (1.8 Mmt) (FAO 2021). The Philippines has been a leader in seaweed production for three decades until 2007, when Indonesia surpassed production in 2008 (Hurtado et al. 2015). In 2009, Indonesia produced 85,000 mt of dry seaweed, while the country only produced 61,000 mt (Valderrama 2012). Farm production was centered on two genera, *Kappahycus* and *Eucheuma*. The reduction in the country's production was attributed to the 'ice-ice' disease outbreak brought about by unfavorable weather conditions and political instability in farming areas (Valderrama 2012; Valderrama et al. 2015). The highest production was recorded at 1.84 mt in 2011, but production started to follow a downward trend and has not recovered since then (BFAR 2022).

Seaweed farming significantly contributes to the improvement of the socioeconomic status of coastal communities (Hayashi et al. 2010). An estimated 200,000 families in the country rely on seaweed farming as their primary source of income (SIAP 2017), mainly due to relatively simple technology, low investment capital, and a short culture period of 45-60 days (Valderrama 2012). A varying profit margin of 22-82% can be realized in seaweed farming (Hurtado 2013). Hurtado et al. (2015) also stated that properly managed seaweed farming could earn more than US$ 800 yr^{-1}. Over the years, seaweed farming served as an important livelihood in coastal areas (Trono and Ganzon-Fortes 1989; Ask et al. 2003). It has generated employment for many coastal families in the country (Hurtado 2013), and positively impacted the coastal villages' socioeconomic aspect (Hayashi et al. 2010; Msuya 1998). Aside from providing a stable annual income, it improves household economic status, thus, resulting in a sustainable way of life (Zamroni and Yamao 2011), and promoting community well-being (Rimmer et al. 2021). Moreover, employment opportunities provided by seaweed farming during the initial stages helped empower women in coastal communities (Cooke 2004), where extra labor during the planting process is necessary (Zamroni and Yamao 2011).

In Palawan, there is an estimated aggregate farming area of 13,774 ha in the province but only 5,567 ha are being utilized by 7,604 farmers with an average farming size of 0.73 ha per farmer (BFAR (2022). There are 11 Eucheumatid cultivars being cultivated with 'spinosum' (*Eucheuma denticulatum*) as the most widely grown. In addition, the cultivars 'cottonii', 'tambalang' and 'giant' for *K. alvarezii* while 'sacol' and 'vanguard' for *Kappaphycus striatus* are utilized for farming (Dumilag et al. 2022). The culture methods employed are fixed-off bottom and hanging long lines. However, due to the expansion of the culture areas, the use of multiple long line methods has been widely adopted in deep (>5 m) waters (Hurtado et al. 2015).

From 2020 to 2021, many Eucheumatid farmers in Palawan experienced economic loss presumably due to the "ice-ice" disease (IID) of seaweed, which is associated with climate change (Largo et al. 2017). IID and epiphyte infestations caused an estimated 15% reduction in total seaweed production in 2018 and can therefore affect the sustainability of seaweed farming in the country (BFAR 2022). Over the years, several strategies (such as submerging the longlines down to 0.5 m below the sea surface and transferring the long lines into deeper locations) to cope with these problems have been employed by farmers, but not much is known about how they react and interact with the situations. Thus, this study sought to explore the farmer's demographics, recent experiences in seaweed farming, medium-term aspirations, and potential factors affecting their positive attitudes toward problems encountered in seaweed farming.

METHODS

Study Area

Coastal barangays from four municipalities that have known Eucheumatid farming activities were selected. These municipalities were Aborlan, Roxas, Taytay, and Puerto Princesa City (Figure 1). The nine barangays: Isaub (9.5106° N, 118.5932°E) and San Juan (9.4341° N, 118.5594° E) in Aborlan, Rizal (10.2386° N, 119.2437° E) in Roxas, Pamantolon (10.9019° N, 119.4528° E), Pularaquen (10.9803° N, 119.4760° E) and Calawag (10.6367° N, 119.5804° E) in Taytay, and Tagburos (9.8352° N, 118.7273° E), Babuyan (9.9908° N, 118.9119° E), and San Rafael (10.0471° N, 118.9412° E) in Puerto Princesa City were chosen as study sites (Figure 1). All these coastal barangays have Eucheumatid farming and fisheries-related activities as their main living sources.

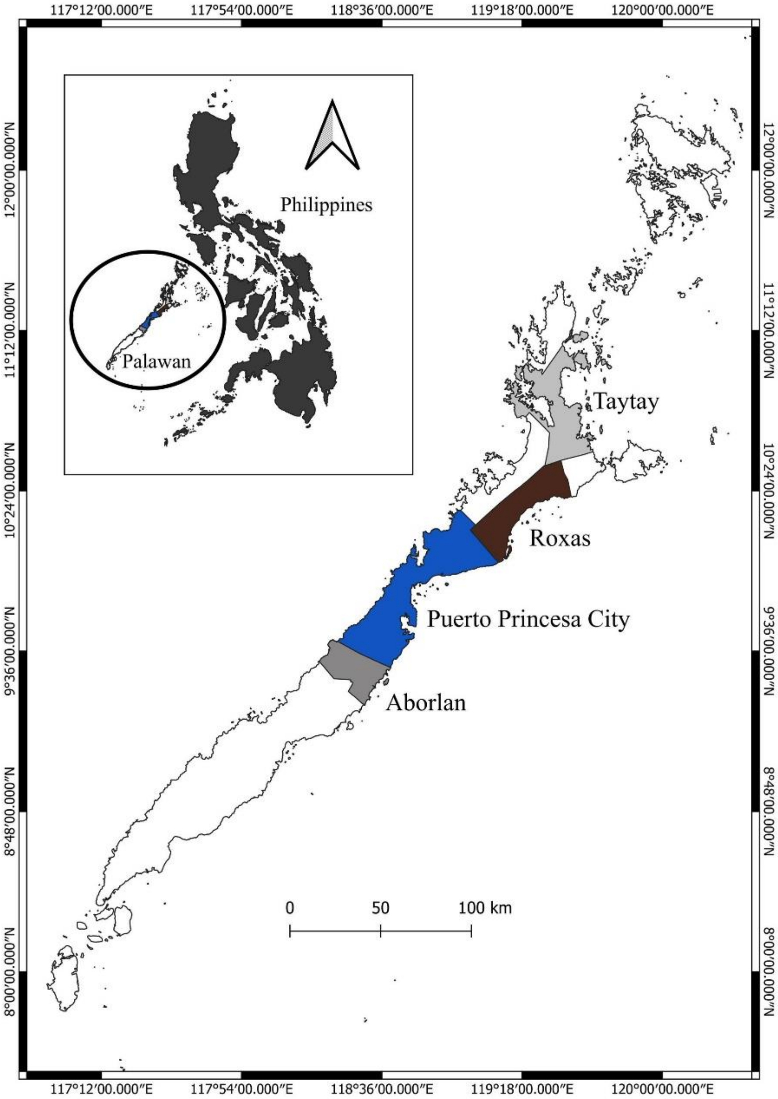

Figure 1. Map of Palawan, showing municipalities where the interview was conducted.

Survey Participants

The participants were taken from a collective survey of preselected fisherfolks from each coastal barangay. Out of the 935 fisherfolks, only 187 were seaweed (Eucheumatid) farmers aged 18 and above. All the respondents were seaweed farmers who lived in the coastal areas of the municipalities surveyed. Aside from seaweed farming, most of them were engaged in fishing as a supplemental livelihood.

Data Collection

This study was conducted from 23 November to 10 December 2021. Approval was sought from each municipal and barangay government before the conduct of study. The participants from Aborlan, Roxas, Taytay and Puerto Princesa were organized through their respective Barangay Fisheries and Aquatic Resources Management Council (BFARMC) representatives and gathered in an open venue in their barangay where health protocols were observed. A face-to-face interview was conducted using a Computer Assisted Personal Interviewing (CAPI) tool on a tablet computer with recorded interview responses under a KoboTool box program. Due to literacy and technology concerns, the interviewers assisted the participants in answering the survey; however, those knowledgeable in the operation of tablet computers were allowed to answer the questions in English alone while an interviewer was on standby for clarifications or further explanation about the questions. The participants were asked using a structured survey questionnaire. The survey was divided into four sections. The first section was about (1) the demographics, followed by (2) their recent experiences in seaweed farming by answering the causes of losses in seaweed farming and how they feel about several activities on seaweed farms, and (3) their medium-term plans for the next 12 months. Their responses to the questions under sections 2-3 were in a Likert-scale questionnaire with five anchor points ("1" - extremely dislike/poor, "2" - poor/dislike, "3" - moderate/neutral, "4" - high/like, and "5" - extremely high/like). All answers were recorded and saved on tablet computers.

A focus group discussion (FGD) was conducted involving 8-10 seaweed farmers (Key Informants) in each study site for section 4 of the survey questionnaire. During the FGD, an open-ended questionnaire was used to identify factors affecting their attitudes toward seaweed farming. Similar answers were grouped and tabulated according to the frequency of answers received, and the summary was presented in a table.

Statistical Treatment

The data from the tablet computers were exported into an Excel file and cleaned before the analysis. Data from the survey were analyzed using SPSS 25, while data collected from FGD were qualitatively analyzed to understand factors affecting their attitude toward seaweed farming.

RESULTS

Profile of the Respondents (Demographics)

The distribution of the participants was: Taytay-116 (62%), Puerto Princesa City-53 (28.4%), Aborlan-16 (8.5%), and Roxas-2 (1.0%). There were 104 (55%) male and 83 (45%) female participants (Figure 2A). Most (86.4%) of the participants were married, while a small portion was widowed (7.4%) and single (6.2%) (Figure 2B). The highest age bracket of participants was 41-50 years old (28.3%), followed by 31-40 years old (26.1%) (Figure 2C). In terms of educational attainment, half (50%) of the participants were able to reach high school (high school level, (25.3%) and high school graduate (24.7%)), while 28.7% were elementary (elementary graduate (19.7%) and elementary level (9.0%)) (Figure 2D).

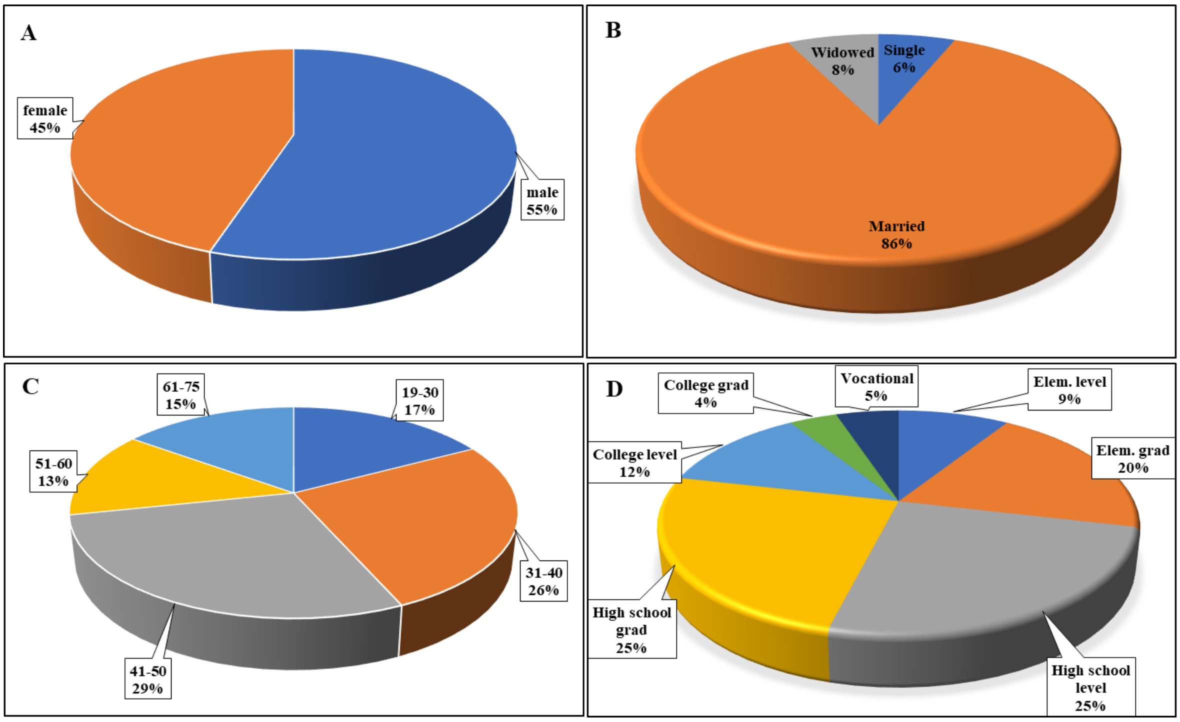

Figure 2. Demographics of the participants across survey sites, sex (2A), civil status (2B), age (years) brackets (2C), and educational attainment (2D) of participants.

The methods of farming largely used were multiple-hanging long lines, single lone lines, triangle ("tumbo-tumbo"), and few utilized fixed-off bottom and multiple rafts (Figure 3A). The triangle and fixed-off bottom were noted in the barangays of Puerto Princesa. Further, 30.5% of the participants were practically new to Eucheumatid farming (1-5 years), 33.1% farmers were moderately old (11-20 years) and 18.7% were old (>21 years) (Figure 3B). The three major cultivars being cultured were 'spinosum' (*E. denticulatum*) and 'sacol' (*K. striatus*) and 'giant' (*K. alvarezii*) (Figure 3C).

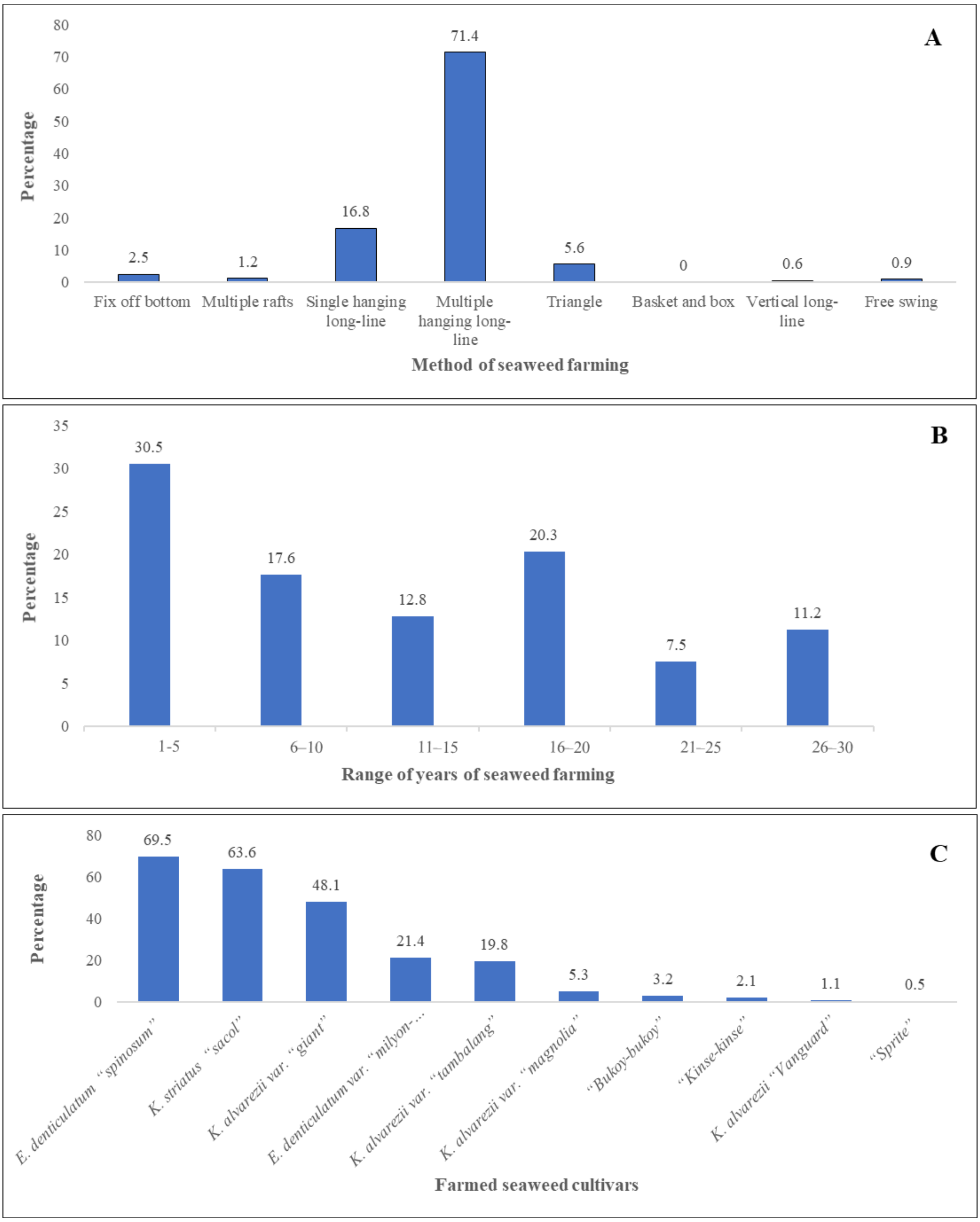

Figure 3. The farming methods practiced by seaweed farmers (3A), years of engagement in seaweed farming (3B), and the seaweed cultivars being farmed in their areas (3C).

Recent Experiences in Seaweed Farming

The recent experience of seaweed farmers, which incurred major economic losses, was primarily due to IID (99.5%), followed by losses from typhoons (82.1%) and epiphyte infestation (64.7%) (Table 1). According to the respondents, upon the onset of IID, it only took a week for the whole plot to get infected and the cultivars to disintegrate and get lost from long lines. The participants also mentioned the presence of epiphytes "buhok-buhok" or filamentous red algae believed to be *Polysiphonia* sp*.,* which worsens the losses. However, several other factors affect productivity in Eucheumatid farming, which includes price fluctuations, poor or insufficient cultivars, drastic weather conditions, typhoons, and farm management. These factors could be the cause for a few respondents (23.5%) who experienced losses even before the onset of the disease. Despite these incidences, most respondents (75.3%) liked to continue to engage in seaweed farming when asked if they were planning for the succeeding cropping. Most of them had anticipated harvesting (89.1%) and getting income from their dried seaweed product (93.3%). Harvesting and drying, for them, were the highlights of seaweed farming. At least 59% of the respondents answered that they earned from seaweed farming before the onset of the disease, while the majority of them (93.5%) had indicated economic loss after its occurrence. More than 50% of them also revealed receiving technical assistance (such as seminars) from government agencies, specifically from the Office of the Municipal Agriculturist (OMA) / Office of Provincial Agriculturist (OPA) (67%), Bureau of Fisheries and Aquatic Resources (BFAR) and other line agencies of the national government (65.9%), and the academe Western Philippines University (WPU)/Palawan State University (PSU) (59.0%). However, it is interesting to note that a small number of responses (21.5- 29.5%) were neutral or perceived to receive poor support from government agencies (Table 2).

Table 1. Diseases/losses of farmed seaweeds observed by farmers in the coastal areas of Taytay, Roxas, Puerto Princesa and Aborlan, Palawan.

Diseases/losses	Number of responses	Percent (%)
a. 'Ice-ice' disease	183	99.5
b. Epiphyte infestation	124	64.7
c. Grazing by turtle	88	47.8
d. Grazing by fish	103	56.0
e. Lost during typhoon	151	82.1

Table 2. Participants' perception about seaweed farming activities, earnings from farming, and technical assistance received during the past 6-12 months (n = 187).

Perceptions	Responses %				
Activities done	**Extremely dislike**	**Dislike**	**Neither dislike nor like**	**Like**	**Extremely like**
a. Planning for next seaweed farming	1.1	2.7	21.0	53.8	21.5
b. Harvesting seaweed from longlines	0	1.1	9.8	53.8	35.3
c. Drying and selling harvested seaweeds	0	1.1	2.7	44.9	51.4
Earning from seaweed farming	**Extremely poor**	**Poor**	**Neutral**	**High**	**Extremely high**
a. Before occurrence of seaweed disease	6.0	17.5	17.5	46.4	12.6
b. After occurrence of seaweed disease	58.7	34.8	6.5	0	0
Technical assistance received	**Extremely poor**	**Poor**	**Neither poor nor satisfactory**	**Satisfactory**	**Highly satisfactory**
a. From LGUs OMA/OPA	2.2	9.7	21.1	55.1	11.9
b. From BFAR and other line agencies	1.1	9.7	23.2	53.5	12.4
c. From WPU/PSU	3.3	8.2	29.5	43.7	15.3

Medium-term Aspirations

Most respondents (92.4%) wanted to restart seaweed farming after the IID incidence that occurred throughout the year, but predominantly after sweltering weather followed by heavy rain. Due to the economic loss from the previous cropping, the same number of farmers (92.4%) wanted to culture other organisms aside from seaweeds to recover from their losses. They also wanted to participate in various activities that would help them become resilient in the advent of unexpected events that might happen at the farms. These include taking part in citizen science activities with WPU/PSU (91.3%), the development of value-added products from seaweeds (86.4%), and actively participating in cooperative/association activities for the marketing of products (87.5%) (Table 3).

Factors Affecting Positive Attitude

The factors identified by seaweed farmers influencing their positive outlook on seaweed farming despite the challenges that beset the industry during the past few months are presented in Table 4. Most of them were optimistic about seaweed farming because of the huge profit that could be derived from this activity, and this served as their primary source of livelihood. Further, the simple technology involved and the fast turnover of cycles enable them to continue to engage in this activity. Besides, this livelihood has been passed over from generation to generation, wherein families were familiar with the various activities involved in seaweed farming. They also considered seaweed farming as a legal livelihood that requires minimum inputs and has the advantage of having a support group.

Table 3. Participants' perception about their plans and aspirations as seaweed farmers for the next 6-12 months (n = 187).

Plan and aspirations for aquafarming activities for the next 12 months	Perceptions (%)				
	Extremely dislike	Dislike	Neutral	Like	Extremely like
a. Restart a seaweed farm	0	2.7	4.9	60.9	31.5
b. Culture other organism aside from seaweeds	0.5	2.2	4.9	58.5	33.9
c. Report observations in the farm to WPU/PSU project and seek technical assistance	0	0.5	8.2	58.7	32.6
d. Participate in developing value-added products from seaweeds	0	1.1	12.5	50.5	35.9
e. Actively participate in cooperative/association activities for marketing of products	0	2.2	10.3	52.7	34.8

Table 4. Factors affecting the positive attitudes of farmers in the surveyed municipalities in Palawan.

Factors	**Score**
Big profit	49
The primary source of livelihood	38
Simple technology	21
Fast turn-over	17
Familiar livelihood	14
Legal livelihood	13
Coop as a support group	10
High market demand	7
Supplemental livelihood	3
Additional capital	1

DISCUSSION

Profile of the Respondents (Demographics)

The respondents were dominated by male (55%), likely due to the off-shore farming practice that is labor-intensive and physical in nature. This finding was corroborated by the results of Mateo et al. (2021), where Palawan farmers use offshore shallow (5-6 m deep) farming techniques and require skills to set up their long lines. However, it was noted during the interview that females helped prepare planting materials and dry harvested seaweeds which also conforms to the study of Mateo et al. (2021). Almost half (43.3%) of the surveyed farmers aged 19-40 years old and engaged in farming for 1-10 years (48.1%), which also conforms to the studies of Tahiluddin et al. (2023) and Mateo (2021). Further, the involvement in this activity at a young age suggests that the knowledge of seaweed farming was passed down from generation to generation (Mateo et al. 2021). Family members obtain first-hand information on seaweed farming early on by helping with rudimentary tasks such as tying cultivars on long lines and drying harvested seaweeds. Further, this also indicates that Eucheumatid seaweed farming (ESF) is a family enterprise (Tahiluddin et al. 2023).

The three popular seaweed cultivars being cultured in the area surveyed were 'spinosum' (69.5%) (*E. denticulatum*), 'sacol' (63.9%) (*K. striatus*) and 'giant' (48.1%) (*K. alvarezii*). According to the farmers, since the onset of IID, they have been cultivating 'spinosum' and 'sacol' as these two were resilient against the disease and can withstand drastic changes in seawater temperature

Recent Experiences in Seaweed Farming

Diseases, pests, and unpredicted weather conditions were disturbances that impacted seaweed production (Suyo et al. 2020). The outbreak of IID and epiphytic algae resulted in a major loss in seaweed farming in the areas surveyed. The disease is characterized by the gradual depigmentation of the seaweed thallus, softening of infected tissues, and eventually, detachment of the infected thalli, resulting in biomass loss (Hurtado et al. 2021; Faisan et al. 2021). The occurrence of diseases such as "ice-ice" and epiphytic algae rendered losses (93.5%) to the seaweed farmers across the survey areas. On the other hand, a small number (23.5%) of participants experienced losses even before the occurrence of diseases, which could probably be due to other factors such as insufficient/poor supply of cultivars, price fluctuations, poor carrageenan content, and weather disruptions. Farmers claimed that a drastic change in weather conditions (rains after very hot mornings) and an elevated water temperature initiated the onset of these diseases. Largo et al. (2017) stated that stressful abiotic conditions are conducive to the emergence of IID and epiphytes in seaweed farms. Epiphyte infestation was observed by the presence of hair-like growth on the thallus that penetrated the outer and inner layers of the host seaweed, exposing the thallus tissues to microbial infection (Hurtado et al. 2021; Hayashi et al. 2010). Initially, tiny black spots become visible on the cortex of the host seaweed, as the epiphyte matures, the appearance of "goosebumps" results in dark pits on the cortical surface making the host susceptible to opportunistic bacteria (Faisan et al. 2021; Ward et al. 2019). Several opportunistic bacteria and other microorganisms have been found to induce IID, such as *Cytophaga-flavobacterium* (Largo et al. 1995), *Alteromonas* and *Pseudoalteromonas* (Syafitri et al. 2017), and marine fungi (*Aspergillus ochraceus, Aspergillus terrius* and *Phoma* sp.) (Solis et al. 2010). Moreover, Hayashi et al. (2010) stated that *Ceramium* and *Neosiphonia-Polysiphonia* were the most harmful epiphytes. *Polysiphonia* caused massive losses in *K. alvarezii* production in the Philippines and Malaysia (Hurtado and Critchley 2006). Extreme surface seawater temperature changes increase seaweed susceptibility to pathogens (Largo et al. 2017) and reduce seaweed productivity and quality by lowering iota levels, yield, gel strength, and viscosity (Mendoza et al. 2002). According to Zabala and Gonzales-Plasus (2020), IID and epiphytic filamentous algae were observed in March-December and February-May in Palawan, respectively.

The continuous spread and outbreaks of these diseases can further be attributed to the lack of biosecurity measures across the survey areas. Although farmers cut out the infected parts of the seaweeds during the vegetative selection of cultivars, proper disposal was never practiced. In Malaysia, the use of healthy and uninfected propagules, regular simple cleaning of seaweed thallus and farm ropes to remove biofouling and early identification of infected stocks were proven to be effective simple biosecurity measures (Cottier-Cook et al. 2022). Hurtado et al. (2021) and Mateo et al. (2021) further corroborated the lack of biosecurity measures in the country's seaweed industry. The only existing policies in seaweed aquaculture are the Good Aquaculture Practices for seaweeds (GAqP, PNS/BAFS 208:2021 and Dried Raw Seaweeds (RDS, PNS/BAFS85:2021). However, enhancing biosecurity measures will require strict monitoring and implementation of guidelines and the participation of all players in seaweed farming (Hurtado et al. 2021; Mateo et al. 2021; Cottier-Cook et al. 2022). Moreover, simple management strategies such as the implementation of regular cleaning of long lines and manual removal of epiphytes as quickly as possible (Ask and Azanza 2002) and proper disposal can decrease its impact on seaweeds (Ward et al. 2019).

Typhoons are also natural calamities that critically affect Eucheumatid seaweed which the participants also considered as the second (82.1%) reason for their losses. Harvesting the seaweed before the typhoon is one of their management strategies, but sometimes this reduces the price due to low carrageenan content. Another strategy they reported, is to submerge the seaweed lines to 0.5-1 m below the water surface.

The repetitive harvests and utilization from the same mother plant resulted in low-quality or inferior lines of propagules (Hurtado et al. 2015). The use of low-quality cultivars may have aggravated the effects of these factors, such as diseases, climate change, and natural calamities (Largo et al. 2017), preventing farmers from optimizing their production (Ginigaddara and Lankapura 2018), which eventually affected the yield and income of seaweed farmers (Dangan-Galon 2019). According to Largo et al. (2017), a strong genetic foundation determines the resilience of seaweed species to changing environmental conditions. Repetitive monoclonal propagations weaken resistance, affecting metabolic functions and reproductive processes, eventually resulting in loss of seedling quality. Hurtado et al. (2021) stated that to maintain genetic robustness, propagation from naturally occurring stocks or wild populations should be done.

Although there was technical assistance received from government offices, seaweed farmers were left vulnerable to the effects of various production disturbances that were aggravated during COVID-19, which prevented most of the farmers from going out freely and effectively managing their farms. Further, a small number of participants (21.1%-29.5%), divulged that the technical assistance received was not fully utilized to their advantage as reflected by the number of farmers (23.5%) that experienced losses before the onset of IID. The paper of Hurtado et al. (2015) pointed to weak linkages between the academe-scientist-expert group and the seaweed farmers as one of the major technical problems in seaweed farming in the country. Closer interactions pave the way to better education and technology transfer, shared experiences and information, and confirmation of technologies. Subsequently, a more open interaction involving all stakeholders in seaweed farming would provide better answers to exploring various problems (Zamroni and Yamao 2011). Moreover, not all seaweed farmers (10.8-11.9%) could benefit from the assistance/programs provided by the government, and the lack of effective implementation, monitoring, and evaluation further challenged the effectiveness of these programs and projects (Suyo et al. 2020). Grassroot seaweed farmers can provide valuable information on various aspects of seaweed farming that may aid the government in providing appropriate solutions to existing problems (Nor et al. 2017). According to Suyo et al. (2020), the collaboration between various actors in seaweed farming has been seen as a crucial aspect of lessening the risks in seaweed farming. Seaweed farmers may be able to solve minor problems in their farms, but severe problems need interventions from other organizations such as the government and research institutions.

Medium-term Aspirations

Seaweed farming has been the primary livelihood of participants in the study sites and continues to support coastal families over the years, especially those with limited alternative livelihood options (Rimmer et al. 2021) but due to the incurred losses that seaweed farmers experienced after the onset of diseases, they wanted to recover from their losses. They also wanted to culture other organisms that complement seaweeds. Examples of these organisms they wanted to culture were sea cucumber and abalone. Some farmers in Taytay with the highest number of participants have experienced the abalone culture (ADB 2014; Creencia et al. 2018).

Despite the mentioned incidences, seaweed farmers wanted to continue to engage in seaweed farming because this activity is a significant source of their livelihood. This finding was corroborated by the study of Rimmer et al. (2021) and Sudarwati et al. (2020) that seaweed farming is an important livelihood in coastal communities. Further, the continuing global demand for carrageenan (Dumilag et al. 2022; Suyo et al. 2020) will create further expansion in farming. Subsequently, this industry will continue to provide employment opportunities to coastal families (Krishnan and Narayanakumar 2010). Various studies have corroborated this finding to have positive impacts on coastal families' socioeconomic status (Valderrama 2012; Hurtado 2013; Rimmer et al. 2021). Further, seaweed farming has been considered a family business passed down from generation to generation, where almost all the family members participate in all activities to reduce the overall labor cost. The husband usually performs the heavy tasks while the wife and the children assist in the initial preparations, such as tying seaweed cultivars on lines and harvesting and drying harvested seaweeds. These labor contributions performed by other family members were important factors in the success of seaweed farming (Cooke 2004). The low operational cost and simple management after planting allow farmers to engage in other income-generating activities, such as fishing (Ginigaddara and Lankapura 2018), which also help generate additional income. In Indonesia, seaweed farming has been considered a complementary and compatible livelihood with other village activities such as fishing and agriculture. Families highly dependent on seaweeds lacked economic resilience and were vulnerable to ever-changing production cycles. Income diversification is an important coping option to achieve sustainable income (Rimmer et al. 2021). Thus, the development of other income-generating or alternative livelihoods, such as participation in the development of value-added products and joining a cooperative, are some of the strategies that seaweed farmers may engage in. In Indonesia, seaweed farmers and their families engage in a variety of livelihoods including agriculture, fishing, aquaculture, and small business (Zamroni and Yamao 2011; Rimmer et al. 2021).

Joining a cooperative and participating in its marketing activities would pave for a stronger position to negotiate with traders that would positively impact farm gate prices, especially for consolidated volumes of seaweeds. Access to government assistance can be easily achieved through an organized group such as a cooperative (Nor et al. 2017).

Factors Affecting Positive Attitude

Seaweed farming is perceived as an important livelihood of the participants surveyed and is considered a family business that was handed down for generations. According to them, they would rather engage in a livelihood they are familiar with than do a job that needs higher skills and education. Most (78.7%) of the participants were in elementary and high school levels of education. This is supported by the study of Mateo et al. (2021) that the majority of farmers in Palawan were in primary and secondary levels of education. The promise of high economic returns is one factor that makes farmers positive and reliant on seaweed farming. This conforms to the studies of Valderrama (2012) and FAO (2018) that the socioeconomic impacts of seaweed farming have been positive and very significant in coastal communities. Moreover, the study by Zacharia et al. (2015) stated that seaweed farming plays an important role in the livelihood improvement of coastal families. Various studies corroborated that seaweed farming is an important livelihood that brings sustainable income to the coastal villages (Trono and Ganzon-Fortes 1989; Ask et al. 2003; Ginigaddara and Lankapura 2018). In cases where family labor is insufficient during the initial preparations for seaweed farming, additional labor was employed to support the labor force. This is viewed as an opportunity to create employment in the seaweed industry. These economic impacts were corroborated in various studies (Msuya 2006; Bindu and Levine 2011; Zamroni and Yamao 2011). According to the participants, they lack capital investment, which renders them not fully benefiting from the economies of scale (Hurtado 2013). Further, they claimed that seaweed farming is a legal livelihood, and it utilizes low investment, simple technology, and a short culture period of 45-60 days. The thought of investment being monetized in a short period is necessary for them to support the family's needs. Further, this enables them to continue to rely on seaweed farming and engage in other livelihoods, such as fishing for additional income (Mateo et al. 2021).

Villanueva et al. (2011) reported that *Kappaphycus* seaweeds exhibit fast growth during the first few weeks of culture, which conforms with the harvest period of 45-60 days, allowing rapid turnover of investment in a short cycle. However, to attain sustainable seaweed production, various factors should be considered. A greater understanding of pathogenic and physiological diseases that will lead to early detection and possible outbreaks, an understanding of environmental conditions, the adaptation of farming management, and the use of genetically diverse and resistant cultivars are factors that can impact production and yield (Ward et al. 2019). Developing advanced and cost-efficient cultivation technologies is also important (Kim et al. 2017). The use of inorganic nutrient enrichment by farmers in Sibutu, Tawi-Tawi, in southern Philippines has proven to improve growth and mitigate IID (Tahiluddin et al. 2022). Subsequently, Echem (2017) noted that using nitrates and phosphates increased macroalgae biomass *(Gracilaria arcuata, K. alvarezii, and E. denticulatum*) in laboratory experiments. These techniques were innovations that farmers employed in the hope of increasing production which is absent in the areas surveyed, although seaweed farmers in Palawan have a fair knowledge of Eucheumatid seaweed farming and practices (Mateo et al. 2021). Further, Suyo et al. (2021) stated that seaweed farmers' perceptions and understanding were influenced by their experiences and roles in seaweed farming.

Seaweed farmers in Palawan will continue to engage in seaweed farming primarily because of its high economic returns, low investment requirement, short culture period, and practically simple technology. Moreover, this legal livelihood has been handed over for generations and is perceived as an important source of income. Being a major income-generating activity, seaweed farming will continue to play an important role in providing livelihood in coastal communities despite various challenges. These factors will continue to serve as drivers of the positive attitude of the farmers toward seaweed farming. However, various factors should be considered to adapt to the changing environmental conditions that would lead to sustainable seaweed farming. The use of resistant and diverse cultivars, advanced farming technologies, and a greater understanding of the physiological processes involving the occurrence of diseases and pathogenic agents would impact production and yield.

The development of other alternative livelihoods will enable seaweed farmers to become more resilient to the risks of engaging in one livelihood. Diversification and employing integrated farming systems would help in becoming resilient in the advent of environmental and anthropogenic hazards. Joining a cooperative could boost the morale of seaweed farmers by looking at the organization as a support group and a venue to access assistance from the government. Subsequently, cooperatives can serve as a group that provides support in times of difficulties and serve as a channel for working together for the spirit of "bayanihan" or community cooperation. Further, the organization's sense of belonging will also help foster a positive attitude among seaweed farmers. Subsequently, strong collaboration with various stakeholders in seaweed farming would pave the way for a concerted effort to address industry problems.

Moreover, Palawan is an island province with vast coastal areas, wild stocks of seaweeds, and clear waters that have the potential to expand Eucheumatid farming. Thus, this livelihood will continue to persist and expand in areas free from pollution and other anthropogenic disturbances. Strengthening collaboration and linkages between stakeholders, research institutions, and government units should be enhanced to address problems to sustain the industry.

FUNDING

This study was funded by the Commission on Higher Education (CHED) under the RDE Program

"Entrepreneurship Education for Fisherfolks and Aquafarmers towards Developing Farm-Gate Markets for Aquatic Products (EEFFMAP)" implemented by the Western Philippines University (WPU) in collaboration with Palawan State University (PSU).

ETHICAL CONSIDERATIONS

The survey protocol of this study was submitted for ethics approval to the National Ethics Committee (2021-023-Creencia-Palawan) of the Department of Science and Technology, Philippines. Revisions as per NEC recommendations were implemented before the conduct of this study.

DECLARATION OF COMPETING INTEREST

The authors declare that there are no competing interests to any authors.

ACKNOWLEDGMENTS

The authors would like to extend their appreciation to the Local Government Units and all study participants of Puerto Princesa City, Aborlan, Roxas, and Taytay in Palawan, Philippines. Also, thanks to the anonymous reviewers who contributed to the refinement of this paper.

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