BIBLIOGRAPHY

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ABSTRACT

This study was conducted mainly to analyze the cost and initial productivity of establishing a sorjan-type aqua-agrisilviculture system of agroforestry.

Results shows that in the yield per commodity green onions had the highest yield of 42.195 kg, followed by the sweet potato which was 12.675 kg, while the lowest yield was obtained from fish component with9.002 kg. Meanwhile the monthly mean growth of fish increased greatly between January and February. Among the perennials, calliandra had lesser increase in height compared to flemingia.

The total cost incurred in establishing the aqua-agrisilvicultural system was P6,937.08. However, a return on investment of 35.94% was computed based on the amortized cost. The payback period is 1.32 years.

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INTRODUCTION

Agroforestry is defined as "all practices that involve a close association of trees with crops, animals, and/or pasture. This association is both ecological and economic. It may involve a combination of practices in the same place at the same time (intercropping and related practices), or practices in the same place but at different times (rotational practices). The place may be as small as a single garden or cropland plot or as extensive as a small watershed or a vast of communal grazing land" (Rocheleau et. al. 1988). It can also provide small landowners under the land reform programs of our government opportunities to maximize the efficient utilization of their limited resources to produce more food and contribute to the attainment of self-sufficiency.

Aqua-agrisilviculture is a system of Agroforestry that involves the combination of agricultural crops, woody perennials, and aquaculture in the same land management unit. All the components in the system are interrelated in varying degrees. For example, in this particular system, the tilapia (aquatic component) will be included to optimize the use of the area because of its swampy condition. Non-marketable vegetables/crops and the tree clippings will serve as sources of feed for the tilapia and as green manure for the farm. Trees planted along the perimeter shall serve as shelterbelt or windbreak to protect the other components and the litterfall will be used as mulch. All of the components produce a product or products that can be sold for income or can be utilized in the farm.

With the continuous increase in the population of the Philippines, the government is facing the problem of supplying the food needs of its people. As population increases and land grown food supplies are unable to feed the growing numbers of mouths, man is turning more and more to water for his food. On land, man is slowly learning to conserve the soil lest it stops producing crops. If the bounty of the waters is not exhausted, men must learn to farm it as he farms the land, by sowing as well as reaping (Cruz, 1976).

Much effort is being spent to increase food production in the Philippines. It seems advisable that the potential thousands of hectares of land available for Agroforestry can be farmed by adapting different systems such as aqua-agrisilviculture. If these areas are devoted for integrated livestock, poultry, field crops, trees and even fish, then malnutrition can probably be minimized, especially in the rural areas where scarcity of protein-rich food is a problem.

In establishing Agroforestry, it is important to estimate the costs involved for farmers to know how much capital is needed in establishing the system and whether the system is adapted to the locality or not. Another is to know if the project will gain or not and to evaluate a project in terms of all relevant costs and benefits associated with such project. If the project benefits are greater than the project costs; then the project is economically feasible or profitable.

In general, the study aimed to determine the initial cost of establishing and the partial initial productivity of the newly established aqua-agrisilvicultural system of Agroforestry in La Trinidad, Benguet.

Specifically, the study was conducted to: 1) determine the cost of establishing a 198 square-meter sorjan-type aqua agrisilvicultural agroforestry system; 2) compute the cost of inputs involved, and; 3) obtain the partial productivity of the system using economic tools.

The study was conducted in the experimental area of the Department of Agroforestry located at the main campus of Benguet State University, La Trinidad, and Benguet from October 2005 to February 2006.

REVIEW OF LITERATURE

Agoforestry is the unique combination of trees and crops and livestock in the agricultural landscape. An old practice observed for thousands of years around the world, Agroforestry is making a comeback in modern farming system (Zhu, 1991). In addition Agroforestry is viewed as the most promising land use for cultivated lands. The components can be arranged in a wide variety of temporal and spatial arrangements. The woody perennials primarily provide site protection and the agricultural crops and livestock principally provide economic benefits (Del Castillo 1994).

Agroforestry has different classifications, like the agrisulvicultural system that involves the combination of agronomic crops, and forest trees (Vergara and Briones, 1987), aqua-silvicultural system, which involves the combination of fisheries and trees in the same area, and the aqua-agrisilvicultural system, which involves the concurrent production of agricultural crops, trees, and fish in the same land management unit.

According to Rocheleau *et. al*. (1998), Agroforestry practices contribute a wide range of benefits and services to the rural community. In addition, Agroforestry is often designed to protect and improve the quality of natural resources including soil, water, vegetation and wildlife and as substitute to the destructive use of special environments such as ravine forests, hill slopes and fragile range lands.

Noble (1997) and Stoney and Bratamiharja (1990), stated that Agroforestry systems promote the spread of biodiversity as monoculture cultivation plots are replaced with a multi-species arrangement, which, as stated by PCARRD (1991), also reduces the risk of devastating pest attacks. In Addition, these diverse populations influence each other through feeding interrelationships, thereby providing a mechanism for check and balance of each population.

The immediate benefits from Agroforestry, by virtue of its protective and ameliorative roles, are envisioned to give further long-term benefits. For a subsistence farmer, Agroforestry is designed to increase and sustain crop productivity in his land and improve his socio-economic standing, nutrition, and health of his family. As a whole, however, Agroforestry practices should lead to stabilized land use policy for the upland and, subsequently, to improved environmental conservation (Vergara and Briones, 1987). Wang and Feng (1994), added that the environment and economic benefits of Agroforestry are diverse, vast and numerous. A study on the North China plain revealed that Agroforestry exhibits an advantage over monocropping in its natural ability to sequester carbon from the atmosphere at a yearly rate of about 1.23×10^6 tons of carbon.

The advantages of integrated system is that it promotes full utilization of the natural resources, full development of available resources to increase food production and recycling of wastes, which maintains a balanced ecosystem and improves the socio-economic conditions of a fish farm by increasing income and employment opportunities (DA-CAR, 1999).

According to PCARRD (1976), systems of multiple cropping/integrated farming are potentially very effective techniques for increasing food production and income especially as supplement to rice and other major crops in the Philippines. Also the average size of farm per farmer in the country is generally very small, thus the systems are needed for attainment of increased food production and income. Furthermore, a farming system should take into consideration all farming attributes and weigh these according to the best means they can be utilized. They may advocate the raising of two or more different crops, livestock or even fish in a given area at the same time or in sequence in a year. In other words, they have flexibility in producing livestock and crops through interaction.

Combining the principles of forestry with agriculture, Agroforestry plays an integral and vital role for more than one billion subsistence farmers who tend lands of a size of less than 1.2 hectares by increasing the profitability of their small tracts of land (Anonymous, 2001).

MATERIALS AND METHOD

The study was conducted in the experimental area of the Department of Agroforestry located at the main campus of the Benguet State University, La Trinidad, Benguet from October 2005 to February 2006.

The inputs needed in establishing the Aqua-Agrisilvicultural Agroforestry system are the labor and materials, consisting mainly of sacks for making dikes, farm supplies, planting materials, and tilapia stocks. The planting materials include the green onion (*Allium cepa* L.), seedlings of flemingia (*Flemingia macrophylla)* and calliandra *(Calliandra calothyrsus* Meiisner), and sweet potato (*Ipomea batatas* L) cuttings. The tilapia stock consists of #17 fingerlings of Nile Tilapia *(Oreochromis niloticus* L.*)* that were acquired from the La Trinidad Fish Farm at Balili, La Trinidad. Shovels and other digging implements and the water pump used to drain the ponds under construction were borrowed from the Agroforestry department while the fuel needed to operate the pump during the pond construction and harvesting of tilapia was procured by the researcher.

Procedures of Establishment

An area having 198 square meters with existing *Alnus* trees in the western portion of the Agroforestry laboratory farm (illustrated in Figure 1) was thoroughly prepared through the following activities:

A. Fishpond construction and fish component

In constructing the three fishponds, measuring 3m x 7 m each and 3 meters apart, dikes were constructed 0.75 m high from the original ground level. Each pond was dug 0.75 m and the earth dug from the pond was used to elevate the spaces in between to a height of 0.75m, so that each pond had a total depth of 1.5 m. Since the area is low-lying and swampy, a water pump was used in draining the pond under construction. The earth removed was put in sacks and piled along the dikes for stabilization (Plate 1). Before releasing the fingerlings, the water pH was taken first and raised to 6.5. Fingerlings of Nile *Tilapia (Oreochromis niloticus L.)* were released with a stocking rate of five fish per square meter. Supplemental feeding with commercial feeds was given at the rate of five percent biomass.

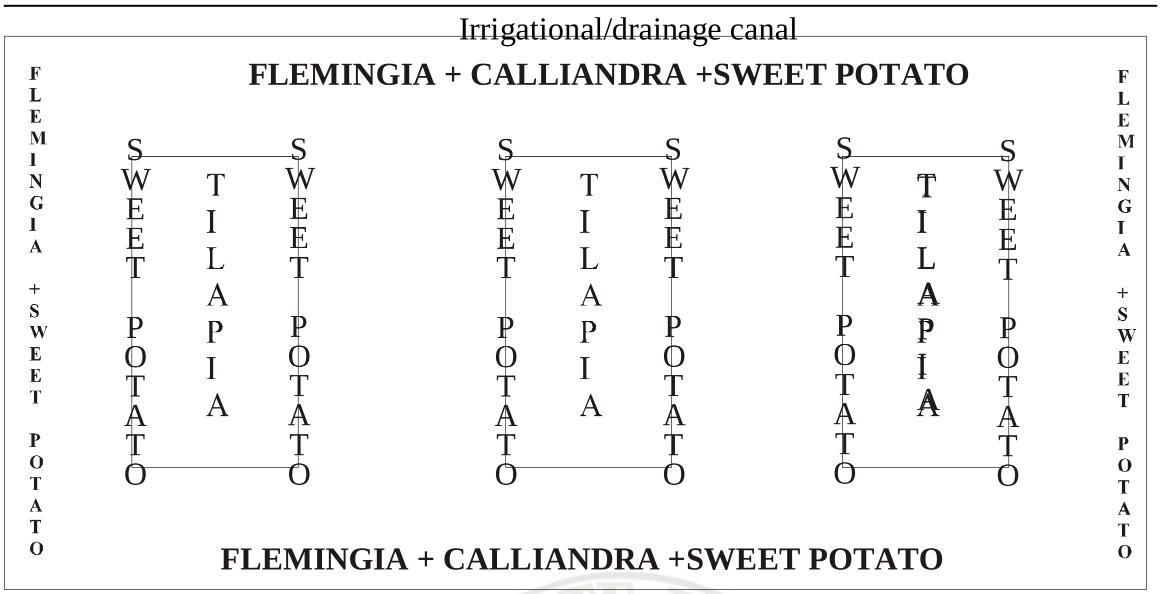
B. Planting of Tree component

Seedlings of *Flemingia macrophylla and Calliandra calothyrsus* Meiisner were planted along the outer edges of the dikes as perimeter plants in the system to augment the already existing *Alnus sp.* trees. This component will protect crops from strong sunlight and wind and minimize soil erosion and run-off once it becomes well established.

C. Planting of Herbaceous component

Green onions (*Allium cepa* L.) were planted after thoroughly preparing the elevated area in between the ponds. Chicken dung was applied as fertilizer and planting was done a week after. Sweet potato (*Ipomoea batatas* L.) cuttings were planted along the edges of the dikes to serve as soil cover and help stabilize the top of the dikes (Plate 2).

These two herbaceous components serve mainly as cash crops, source of food/fodder, and as groundcover to protect the soil from rainfall. The trimmings and residues serve as mulch and become fertilizers for the tree component upon decomposition.



Existing Alnus trees

TOP VIEW

SIDE VIEW

Figure 1. Farm Layout

Plate 1. The newly established system showing the dikes stabilized by sacks

Plate 2. Sweet potato and onion components (left) planted along the outer edges of the dike and onion planted on the dikes in between ponds (right)

Data gathered

1. Cost of establishing the system (₱). All the expenses incurred during the farm establishment were listed for the whole area. Later the total cost was taken by summing up the expenses used for labor and materials per commodity in establishing the system.

2. Growth and Yield Parameters

a. Tilapia. The growth of tilapia was taken through measurements made from 16 sample fishes every 30 days interval from the second month by weighing with a scale and measuring the body length and depth with by a ruler. The yield was measured by weighing all the fish harvested.

b. Green Onions. The yield of onions was determined by weighing the harvest.

c. *Flemingia* and *Calliandra.* Only the growth *of Flemingia* and *Calliandra* were measured by taking the monthly height. The yields were not taken because these are perennials and will produce woody stems that can be utilized as trellis or firewood after a year or so. Instead, the trees were assigned an estimated value at the termination of the study.

d. Sweet potato (vines and leaves). The yield of the sweet potato vines and leaves was measured by weighing them after harvest.

3. Total yield. This was determined by getting the total harvestable yield of the study area. For the perennials, an estimated value was assigned to the standing crops based on their growth. Plate 3 shows the harvested onion and harvesting and measuring of tilapia.

4. Return on Investment. This was computed after 4 months when some components were harvested by using the formula:

$$ROI = \frac{\text{Gross Sales - Expenses}}{\text{Expenses}} \times 100$$

6. Payback period. This refers to the number of years it takes to recover all the capital investment and was computed by using the formula:

$$\text{Payback period} = \frac{\text{Cost of investment}}{\text{Net income}}$$

a

b

c

Plate 3. Harvesting of onion (a) and tilapia (b) and measuring of tilapia (c)

RESULTS AND DISCUSSION

1. Cost of establishment (₱).

The total cost of establishing the system broken down into components is shown in Table 1. The fishpond construction incurred the highest cost of ₱4,145.58 since it required several materials and was quite laborious, followed by the fish component which had a total cost of ₱ 1.331.50, consisting mainly of cost of feed. The lowest cost was incurred in sweet potato (₱ 400.00) due to little maintenance and input required. The table also shows that labor contributed more (₱ 3,875.00) to the total cost of establishing the system.

Table 1**.** Cost of establishing the system (₱).

COMMODITY/ACTIVITY	LABOR (₱)	MATERIALS (₱)	TOTAL COSTS
Fish Pond Construction	2, 925.00	1, 220.58	4,145.58
Fingerlings and feeds	300.00	1,031.50	1,331.50
Onions	300.00	220.00	460.00
Sweet Potato	200.00	200.00	400.00
Flemengia/Calliandra	150.00	390.00	540.00
TOTAL	3,875.00	3,062.08	6,937.08

Growth and Yield Parameters

2. Percent mortality of tilapia

Table 2 presents the mortality of fish per pond. Out of the 105 fingerlings of tilapia released in each pond, the highest mortality was taken from pond 3 with 54%, followed by the pond 2 with 39%. Pond 1 had the lowest mortality of 29%. The relatively high mortality rates were probably and mainly caused by the low pond water temperature during the study, which coincided with the coolest season of the year, and the presence of competitors, such as 'mosquito or million' fish, toads and tadpoles.

Table 2. Mortality rate (%)

POND	TOTAL NUMBER OF TILAPIA RELEASED	TILAPIA GATHERED	MORTALITY (%)
1	105	75	29
2	105	64	39
3	105	48	54
TOTAL	315	187	122

3. <u>Monthly growth of tilapia</u>

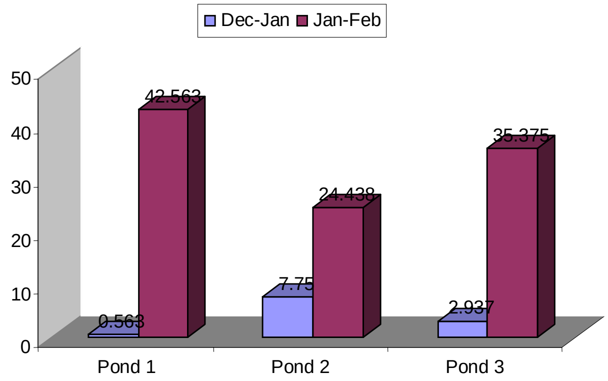
Table 3 shows the monthly measurements of 16 sample fishes per pond. The growth of individual fish per pond was taken in terms of body weight (grams), length (cm), and depth (cm) from December to February. It was found out that the growth of fish was fastest in the February with the biggest increase in body weight, length and depth. At the end of the study, which was four months after stocking, Pond 1 produced the heaviest (53.375g) and biggest fishes with mean body length of 13.725 cm and body depth of 4.631 cm.

Table 3. Mean monthly measurements of fish per pond (grams)

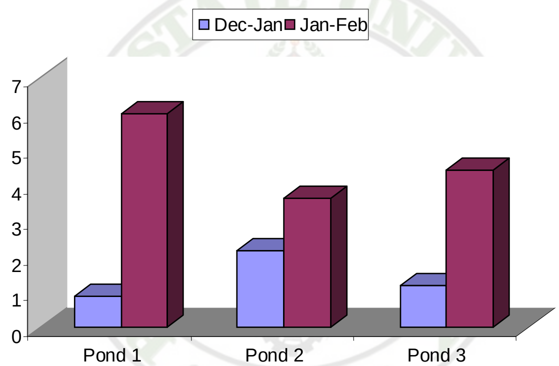
POND	MONTH	PARAMETERS		
		WEIGHT (grams)	BODY LENGTH (cm)	BODY DEPTH (cm)
1	DECEMBER	10.250	6.831	2.231
	JANUARY	10.813	7.706	2.643
	FEBRUARY	53.375	13.725	4.631
2	DECEMBER	10.625	7.206	2.362
	JANUARY	18.375	9.362	3.031
	FEBRUARY	42.813	12.988	4.038
3	DECEMBER	9.438	7.381	24.625
	JANUARY	12.375	85.563	28.313
	FEBRUARY	47.750	129.938	45.438

Figure 2 shows the mean monthly growth increment of tilapia in terms of weight (a), body length (b) and depth (c). The rapid increase in size may be attributed to the increased feed intake of the fish and the higher pond water temperature during the later part of the study.

(a) Increase in body weight (gram)



(b) Increase in body length (cm)



(c) Increase in body depth (cm)

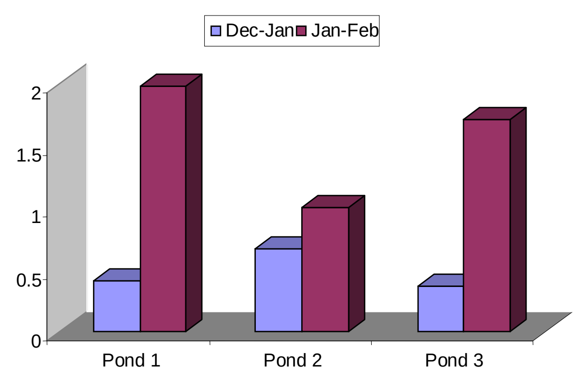


Figure 2. Increase in growth of tilapia per pond.

4. Yield of tilapia per pond (kg)

Table 4 shows the yield of fish per pond that was gathered. The high mortality rate resulted to low from each pond. Pond 1 had the highest total yield was with 3.5 kg followed by 2.762 kg from pond 3 while the lowest yield was obtained from pond 2 with 2.74 kg.

Table 4. Yield of Tilapia per pond (kg)

POND	NO. OF FISH HARVESTED	YIELD (Kg)
1	75	3.500
2	64	2.740
3	57	2.762
TOTAL	148	9.002

5.Yield of green onions (kg)

The table 5 presents the yield of onions and the number of days to harvest, which is 117 days after planting. There were very little differences in the yield per area surrounding the ponds because of the uniform soil characteristics and management system.

Table 5. Yield of green onions (kg)

BLOCKS	NUMBER OF DAYS TO HARVEST	YIELD (Kg)
1	117	10.490
2	117	10.940
3	117	10.680
Total		32.110

6. Monthly growth of *Flemingia* and *Calliandra* (cm).

Table 6 presents the initial and final height of *Flemingia* and *Calliandra*; the *Flemingia* had the highest increment while the *calliandra* had the lowest increment (Fig. 3) from the initial to final height for it takes month for the recovery of the roots that were damage during the transplanting of the seedling.

Table 6. Monthly Height of Flemengia and Calliandra (cm)

COMMODITY	INITIAL HEIGHT	FINAL HEIGHT	INCREASE IN HEIGHT
FLEMENGIA	5.2	7.32	2.10
CALLIANDRA	19.2	19.81	0.81

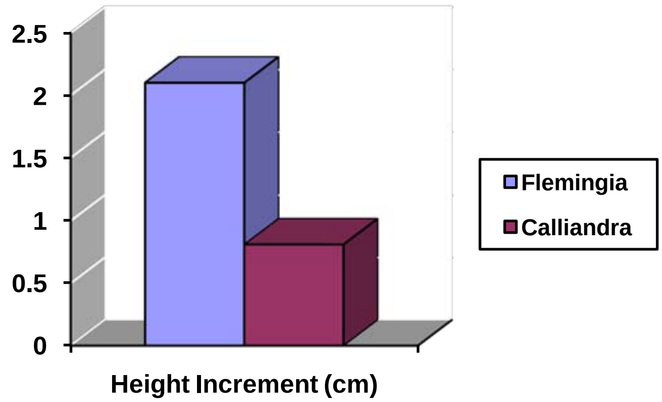


Figure 3. Height Increment of Flemingia and Calliandra (cm)

7. Total yield per unit area.

The total yield per unit area shown in Table 7, the onions has the highest total yield from Block 2 with 19.875 kg followed by Block 3-19.162 kg then the total yield from the Block 1 with 14.750 kg.

Table 7. Total yield per unit area (kg)

BLOCK	FISH (Kg)	ONIONS (Kg)	SWEET POTATO (LEAVES AND VINES (Kg)	TOTAL
I	3.5	10.490	0.760	14.750
II	2.74	10.940	6.195	19.875
III	2.762	10.680	5.720	19.162
Total	9.002	32.110	12.675	53.787

Economic Parameters

8. Return on Investment.

Table 8 presents the Return on Investment of the experiment based on the amortized cost. An ROI of 35.94% shows that establishing a sorjan-type aqua agrisilvicultural system can produce income. Once the maturity and productivity of the other components (trees and sweet potato) is reached, the net returns will be increased.

9. Payback Period.

From the study, the amortized cost of investment per year is ₱3,425.11 while the expected returns after 4 months is ₱ 3,368.37. The computed net returns for 1 year (12 months) is ₱ 2,581.86. Therefore, the computed payback period is 1.32 years.

Table 8. Return on Investment

PARAMETERS	
A. Sales, Php	
Tilapia	630.14
Green Onions	577.98
Sweet potato	380.25
B. Value of Standing Crops	1,810.00
TOTAL RETURNS	3,368.37
C. Inputs	
Fish pond construction (amortized)	315.79
- Fingerlings	236.25
- Feeds	771.50
Green Onions (labor)	300.00
- Planting material	120.00
- Chicken dung (1/2 sack)	40.00
Sweet potato (labor)	200.00
- Cutting	120.00
Flemingia/ Calliandra (labor)	150.00
- Flemingia seedling	175.00
- Calliandra	165.00
- Rabbit Manure	50.00
-	
TOTAL INPUTS, PhP	2,477.75
NET RETURNS, PhP	890.62
RETURN ON INVESTMENT (ROI)	35.94

SUMMARY AND CONCLUSION

Summary

The study was conducted from October 2005 to February 2006. It revealed that establishing an aqua agri-silviculture system by integrating sweet potato, green onions; Flemingia and Calliandra with Tilapia in a sorjan type system incurred a total cost of ₱6, 937.08.

For the yield per commodity, the result shows that the onions had the highest yield of 42.195 kg, followed by the sweet potato which was 12.675 kg, while the lowest yield was obtained from fish with 9.002 kg. Meanwhile the monthly mean growth of fish increased greatly between January and February with the highest mean growth obtained from the pond 1. The lowest mean growth is taken from the pond 2. Among the perennials, Calliandra had lesser increase in height compared to Flemingia.

On the economic parameters, a Return on Investment of 35.94% was computed based on the amortized cost. The payback period is 1.32 years.

Conclusion

The study found out that the Tilapia component is not very productive in the area since the monthly growth is quite slow and because of the presence of other species such as tadpoles and mosquito fish, which compete against the tilapia in eating the feeds. Moreover, slow growth of tilapia was attributed to low water temperature in the study area.

Recommendation

From the results of the study, it is recommended that stocking of tilapia should be done during summer where the temperature is conducive to their growth and bigger size of fingerlings should be used for them to cope up with the growth of other agroforestry components.

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