

Modern Farming Technologies: Impact on Farm Productivity and Food Security in the Rice Terraces of the Cordillera Region, Northern Philippines

ABSTRACT

The study was made to assess the impact of modern farming technologies on the productivity and food security in the rice terraces. The study covered four rice terraces clusters located in four provinces in the Cordillera region in the northern central part of the Philippines. The sites covered are: Haliap, Asipulo, Ifugao, Bagumbayan, Tabuk City in the province of Kalinga, Tanglelan, Calanasan, Apayao and Natonin, Mt. Province. The study is a part of a bigger study conducted for 24 months from January 2011 to December 2013. The study made use of the case study method using 10 key informants supported by interview, workshops and Focus Group Discussion. The results showed that one of the study site still adhere to the traditional system of farming while three had already shifted to modern farming technologies. The three modern farming technologies adopted by farmers are: use modern rice cultivars as a substitute to the traditional varieties, use of fertilizers and pesticides and the use of hand tractors. Modern rice cultivars improved rice production by 70% from the current yield of traditional rice varieties. However, the contemporary increases in production is still not enough to cater to income and food security. Modern rice cultivars created a fit between cash and subsistence wherein the added production improved food security and the surplus is fed to the local market in exchange cash. The mandatory use of fertilizers altered the quality of soil in the rice paddies. Paddies grown with modern rice cultivars are obviously sick with declining pH range. Soil and water are still clean not

Keywords: Modern farming technologies, Impacts, Productivity, Food Security, Fertilizers and Pesticides

1. INTRODUCTION

The Philippine Cordilleras is home to one of the widest and oldest rice terraces throughout the Asian region. Some of these rice terraces clusters were declared by the United States Educational, Scientific and Cultural Organization (UNESCO) as world heritage sites by virtue of their cultural, economic and environmental values to humanity. Modern society today is reaping the benefits of what generations of people in the Cordilleras have built.

The rice terraces is an important part of the local and national economy of the Philippines. It ensures the food security of almost 80% of the local population who are dependent on it for survival. It also contains agro-biodiversity and associated resources that underpin the goods and services it provides to the local community and to society as a whole. The rice terraces also protect watershed and pump prime the growth of the tourism industry.

Historically, the rice terraces flourished as an organic production system. The integration of the region to the economy of the lowland areas in the 1970s brought in so much intercultural and economic exchanges that arbitrarily change the lifestyles and economy of the people. New farming practices and technologies escalated in the rice terraces parallel with traditional agricultural practices. For almost 50 years, 70% of the farming households may have tried either one or two of these new farming practices or technologies. In some parts of the region, farmers have already shifted to modern farming practices but in some areas

traditional farming practices still continue to prevail. In some other parts of the region, farmers are blending both traditional and modern farming practices. Farmers argued that the productivity of traditional rice varieties had been declining over the years and that they have no other recourse but to find ways to increase yield by shifting to high yielding rice varieties. The series of changes that has occurred in the rice terraces captured the attention of policy makers putting the rice terraces in the forefront of public policy debate over the last few years. Is the adoption of modern farming technologies/practices a boon to productivity and food security in the rice terraces? This is the basic question that this current study seek to provide an answer.

2. MATERIALS AND METHODS

This study was part of a bigger project that was conducted for 24 months from January 2011- December 2013 covering four rice terraces clusters located in four provinces in the Cordillera region in the northern part of the Philippines. The four rice terraces clusters are Asipulo, Ifugao, Tanglagan Apayao, Bagumbayan, Kalinga and Natonin, Mt. Province. The collection of data followed a three step inquiry process. The first step consists of a workshop with 10 key informants to get information pertaining to farm characteristics. The second step inquiry was the collection of data on modern farming technologies adopted by farmers and its impact on farm productivity and food security. The second step interview was aided by a semi-structured questionnaire administered on a face to face basis.

The third step consisted of the collection of soil and water samples in each of the study site for routine and pesticide residue analysis. The study adopted the qualitative research approach using the case study method. After the tabulation of the questionnaire, the researcher returned to each of the study site for the validation of data through a Focus Group Discussion (FGD) with at least 15-20 farmers and barangay leaders in each of the study site. Toward the end of the study, a farmers' forum was organized attended by farmers and other stakeholders from the local and national government agencies, non-government organizations and academe to disseminate the output of the research project.

The Vulnerability Assessment Tool for Various Agro-ecosystems (VAST-AGRO tool)[1] was used to determine the sensitivity of income of farmers to climate factors. The VAST-AGRO tool is an excel based assessment tool developed by the agricultural systems cluster of the College of Agriculture of the University of the Philippines in Los Banos, Laguna, Philippines.

3. RESULTS AND DISCUSSION

3.1 Profiles of the rice terraces

The rice terraces assume different elevations along the mountain slopes from the top to the bottom of mountains. Using their relative position along the mountain slopes, the rice terraces can be classified in three agroecological zones such low, medium and high elevation terraces. Low elevation terraces are those found in Tanglagan, Apayao and Bagumbayan, Kalinga with a top elevation 300-500 masl. Medium elevation are those that are within 600-1000 masl while high elevation terraces are those found in Asipulo and Natonin with elevation exceeding 1000 masl. Elevation influence to a large extent the adoption of modern farming technologies where lower elevation terraces were the first to shift to modern farming systems. The adoption of modern farming systems escalated over the last 40 years where three of these selected study sites have shifted to modern farming system while one still adhere to the traditional ways of farming handed down from one generation to another. The physical profiles of the four study site is shown in Table 1.

Table 1. Physical Profiles of the four study sites

Study Sites	Top Elevation (MASL)	Status of the Rice Terraces
Asipulo, Ifugao	1200	Shifted to high yielding rice varieties 1990
Tanglagan, Apayao	300	Shifted to high yielding rice varieties 1980
Bagumbayan, Kalinga	500	Shifted to high yielding rice varieties 1980
Natonin, Mt. Province	1500	Traditional Rice varieties

3.2 Modern farming technologies in the rice terraces

The rice terraces prior to the 1980's persist organically with traditional rice varieties. The transition to modern rice cultivars came only in the early 1980's although there were earlier attempts to do so without much success. The transition came as a response to the declining productivity of traditional rice varieties and intense food insecurity situation in the rice terraces. The modern farming technologies adopted by farmers are: use of high yielding rice varieties, use of fertilizers and pesticides and use of hand tractors replacing human and animal labor

3.2.1 Use of modern rice cultivars

The study site in Bagumbayan and Tanglagan were the first to shift to modern rice cultivars followed by Asipulo in Ifugao province. The study site in Natonin, Mt. Province is still very much traditional adhering to the cultivation of traditional rice varieties. The adoption of modern rice cultivars increased rice production by 80% ensuring enough food supply to the families of rice terraces farmers. However, there are certain trade-off between the cultivation of modern rice cultivars and traditional rice varieties. Modern cultivars are perpetuating the continuing loss of the traditional rice varieties that has endured for many years.

Table 2. Rice varieties cultivated by farmers

Varieties Cultivated	Asipulo, Ifugao	Natonin, Mt. Province	Bagumbayan, Kalinga	Tanglagan, Apayao	Total
Traditional	0	10	0	0	10
Modern	10	0	10	10	30
Others *	3	0	0	3	6
Total	13	10	10	13	46

**those that revert back to the traditional rice varieties occasionally*

3.2.2 Use of pesticides, herbicides and commercial fertilizers

The use of synthetic inputs was alien to the rice terraces prior to the 1980's. The last 40 years were the most crucial period in the history of rice cultivation in the terraces. It was during this period that farmers saw the emergence of new pest and diseases forcing them to try commercial pesticides. Declining soil fertility also led farmers to try commercial inorganic fertilizers which are readily available in the market. The adoption of modern rice cultivars arbitrarily changed the old organic system into inorganic systems with the mandatory use of pesticides, herbicides and commercial fertilizers. Farmers are continually under extreme pressure to change their farming system.

The use of modern cultivars is both a bane and a boon to rice cultivation in the terraces. Farmers use fertilizers and pesticides to remedy nutritional deficiencies in soil and protect crops from pest and diseases. However, inorganic fertilizers had cause changes in soil properties leading to declining pH while pesticides may affect the population of aquatic biodiversity.

Table 3. Use of pesticides and commercial fertilizers

Use of commercial Fertilizers and Pesticides	Asipulo, Ifugao	Natonin, Mt. Province	Bagumbayan, Kalinga	Tanglagan, Apayao	Total
Yes	10	3	9	9	31
No	0	7	1	1	9
Total	10	10	10	10	40

3.2.3 Use of hand tractors

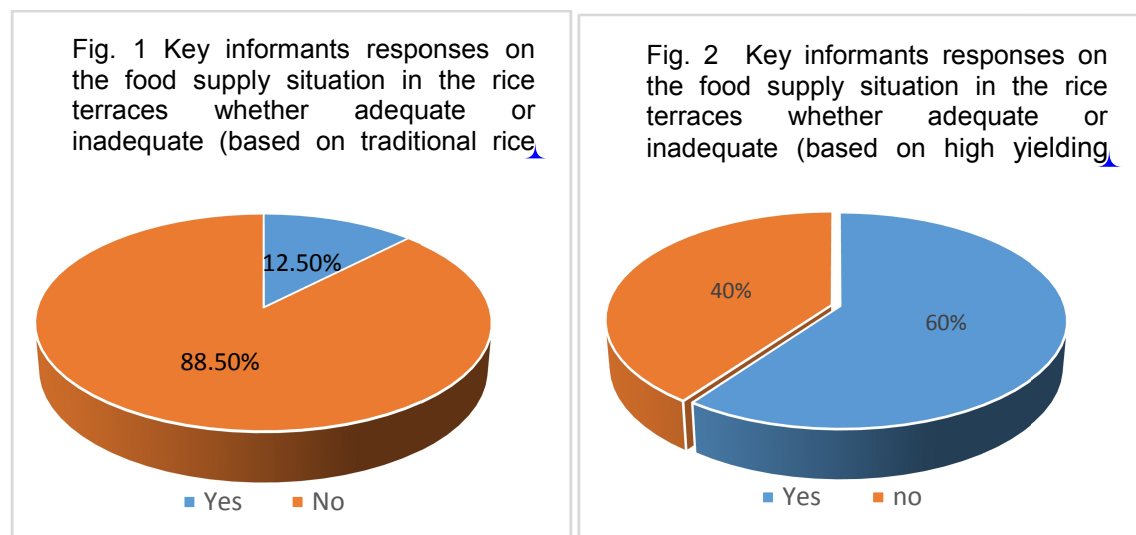
The rice terraces use to be a tedious manual job. Mud puddling is done by hand and feet with the aid of a shovel. The rice terraces use to be inundated with watermaking soil soft and pliable easy for hand working. However, frequent droughts makes soil hard and difficult to cultivate thus farmers had to learn to use either the draft carabao or hand tractor. The use of hand tractor replaced manual labor reducing by 75% the number of man-hours spent in the cultivation of the rice terraces. The distribution of key informants on the adoption of hand tractor is shown in Table 4.

Table 4. Use of hand tractor

Use of hand Tractor	Asipulo, Ifugao	Natonin, Mt. Province	Bagumbayan, Kalinga	Tanglagan, Apayao	Total
Yes	10	0	10	10	30
No	0	10	0	0	10
Total	10	10	10	10	40

4. Modern farming technologies, productivity and food security

Modern farming technologies brought so much relief to the rice terraces farmers. The adoption of high yielding rice varieties more than doubled rice production from the current yield of traditional rice varieties. Modern rice cultivars created a perfect fit between cash and subsistence [2]. Rice is produced firstly to satisfy the food requirement of farming families and the excess is fed to the local market in exchange for cash. The added increases in rice production created a more secure food situation where farmers need not to depend on lowland rice anymore. The food security situation is reflected on the answer of key informants on whether the food supply situation in the rice terraces is adequate or not as indicated in Fig 1 and 2.



Farmers use pesticides to protect crops from pest and diseases and fertilizers to remedy nutrient deficiencies. These are direct intervention measures which are instrumental in harnessing the yield of crops. However, it is apparent that the continued use of commercial fertilizers influenced the pH level of paddy soils in the three study sites that have already shifted to modern farming. Paddy soils in Bagumbayan and Tanglagan exhibit strong acidity while soils in Asipulo exhibit alkalinity. The more traditional site in Natonin exhibit a more neutral soil with higher phosphorous and organic carbon and matter content. The differences in soil pH is in no doubt the effect of commercial fertilizers. The soil quality status of paddy soils in the four study sites is shown in Table 5(a).

Table 5(a). Soil quality status of paddy soils in the four study sites

Study Site	pH	Total N (%)	P (ppm)	K (me/100g.soil)	OC	OM (%)	CEC (%)	(NH ₄ OAC)
Bagumbayan, Kalinga	5.0	0.09	ND (Bray 2)	0.03		1.19	2.05	13.3
Tanglagan, Apayao	5.0	0.03	0.17 (Bray 2)	0.1	2.54	4.37	29.4	
Natonin, Mt. Province	5.5	0.09	158.1 (Bray 2)	0.1	3.84	6.60	46.8	
Haliap, Asipulo Ifugao	7.5	0.05	32.7 (Olsen)	0.4	2.84	4.13	63.5	

Grab water samples were also taken for pesticide residue analysis. The results indicated that pesticides has not affected yet soil and water quality in the three study sites that has shifted to modern farming systems. The result of pesticide residue analysis is shown in Table 5(b).

Table 5(b). Pesticide residue content of soil in the four study sites

Study Sites	Nature of Pesticide	Pesticide Residue (mg/kg or ppm)*
Bagumbayan	Organochlorine, Pyrethroids, and carbamates.	<LOQ
Tanglagan		<LOQ
Haliap		<LOQ
Natonin		<LOQ

*Residue detected below the limit of quantification (LOQ). The LOQ for organophosphates, Organochlorines and pyrethroids is .005 mg./kg. Results obtained by gas-liquid chromatography.

Table 6. Pesticide residue content of water in the four study sites.

Study Sites	Nature of Pesticide	Pesticide Residue (mg/kg or ppm)
Bagumbayan	Organochlorine, Pyrethroids, and carbamates.	*ND
Tanglagan		ND
Haliap		ND
Natonin		ND

*Residue detected below the Limit of Determination (LOD). The LOD for organophosphate is 0 .02 mg./kg and 0.005 mg/kg for organochlorine and pyrethroids. Results obtained by gas-liquid chromatography.

The use of hand tractors brought many benefits to farmers. It reduced labor bottlenecks and freed plenty of man-hours spent in tending the rice terraces which the farmers can spend in doing other tasks. Hand tractors also found application in eliminating giant earthworms and golden apple snail with its rotating cylinders during field preparation. After plowing, farmers drain water from the paddies for a few days to allow giant earthworms to move in. Water is re-applied quickly and harrowing is done with the rotating disk of the hand tractor. Giant earthworms and golden apple snail are crushed and killed in the process.

Higher productivity in the rice terraces may result to better food security. However, food security is not only the function of productivity but also directly link to the availability of additional sources of income. Families with additional sources of income are more food secure than those who depend purely on the rice terraces. The data in Table 6 indicates that income derived from non-climate sensitive sources is much higher than income derived from climate sensitive sources. This would mean that the few household members who are engaged in non-climate sensitive occupation earned much more income than the majority who are engaged in rice terracing and other climate sensitive occupation. Better food security can be achieved when farmers are both engaged in agriculture and other non-agricultural sources of income. Harvest from the rice terraces satisfy the food requirement of families while earnings from non-agricultural sources meets the other financial need of families. The distribution of households according to income sources is shown in Table 7.

Table 7. Distribution of households according to income sources

Sources of Income	Asipulo, Ifugao	Natonin, Mt. Prov.	Bagumbayan, Kalinga	Tanglagan, Apayao	Total
Agriculture	75	21	41	80	217
Agriculture + non-climate sensitive sources	17	29	58	10	114
• % income from sensitive sources	40	15	30	70	155
• % income from non-sensitive sources	60	13	70	30	245
Non-climate sensitive sources	8	50	1.0	10	69
Total	100	100	100	100	100

5. CONCLUSION AND RECOMMENDATION

Modern farming technologies is one of the major drivers of change in the rice terraces. Modern rice cultivars substantially increased the level of production in the rice terraces. The cultivation of modern rice cultivars improved the food security situation in the terraces enabling farmers to create surplus production for the market. However, rice production is still considered meager compared to lowland standard due to limitation imposed by space. On the other hand, the **mandatory** use of commercial inorganic fertilizer under high yielding rice varieties altered the quality of paddy soils in the rice terraces. Paddy soils under high yielding rice varieties are obviously sick with declining pH range compared to the more traditional site in Natonin, Mt. Province that has a more neutral soil. Farmers must learn to moderate the application of fertilizers and mitigate acidity by the application of lime.

Although there are increases in rice production, the contemporary situation in the rice terraces is not enough to cater to income and food security. At the core of this issue is low productivity and food insecurity. The challenge is to set up market oriented entrepreneurship to transform the once subsistence economy into profit centers. Most of the farmers have low access to financial capital except in Asipulo where they have a cooperative servicing their needs. A micro-lending program specifically for rice terraces farmers can be initiated by local cooperatives to help farmers boost production and allow farmers to venture into other areas such as in fish culture and **duck** production. Fish and duck production has huge potential for development in the rice terraces.

The data shows that farmers with a more diverse sources of income are better food secure. In this regard upfront investment are necessary to improve agricultural production and create other sources of income. Investments may include loans, grants and payment of environmental services. Farmers who are capable of capturing the financial value of goods and services derived from the rice terraces are in a better position to do long-term conservation of the rice terraces.

ACKNOWLEDGEMENTS

The author acknowledge with sincerest gratitude The Neys-Van Hoogstraten Foundation (NHF) of the Netherlands for providing the financial grant that was used in the implementation of this research project. The same strong appreciation goes to the Ifugao State University (IFSU) for allowing the author to be engaged in this project. To the rice terraces farmers for their patience and understanding in allowing the

researcher and staff to work with them during the interviews and workshops. My profound gratitude to all of you.

COMPETING INTEREST

Author declared no competing interest exist.

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