# Factors Contributing to Poverty Incidence in Irrigated and Rainfed Ecosystems in Central Myanmar (2008)

**Kyaw Swar Htoo, Charuk Singhapreecha* and Prapinwadee Sirisupluxna**


## ABSTRACT

Farm-level household data collected during 2008 from 370 households in four villages were used to measure the incidence, depth and severity of poverty among farm households under irrigated and rainfed ecosystems in central Myanmar. The study found that the mean per capita income used as an indicator of relative poverty for irrigated households was higher than that for rainfed households, while the percentage of households living below the poverty line was lower among irrigated households than among rainfed households. The poverty regression results showed that an increase in household size could increase significantly the probability of poverty incidence, which in turn could be reduced significantly, especially by changing from rainfed ecosystems to irrigated ones, by creating more farm jobs and by growing more rice.


**Keywords:** Central Myanmar, poverty, irrigation, rainfed, ecosystem


## บทคัดย่อ

ข้อมูลครัวเรือนระดับฟาร์มที่เก็บในระหว่างปี 2008 จำนวน 370 ตัวอย่างจาก 4 หมู่บ้านถูกใช้ในการวัดขนาดและความรุนแรงของความยากจนระหว่างครัวเรือนทำการเกษตร ภายใต้การชลประทานและครัวเรือนที่ต้องพึ่งพาน้ำฝนในภาคกลางของประเทศสาธารณรัฐแห่งสหภาพพม่า การศึกษานี้จะใช้ระดับรายได้เฉลี่ยต่อหัวเป็นตัวชี้วัดความยากจน ซึ่งพบว่าครัวเรือนที่อยู่ภายใต้การชลประทานจะมีระดับรายได้เฉลี่ยต่อหัวสูงกว่าครัวเรือนที่ต้องพึ่งพาน้ำฝน ในขณะที่สัดส่วนจำนวนครัวเรือนที่อยู่ใต้เส้นความยากจนนั้นครัวเรือนที่อยู่ภายใต้การชลประทานจะมีสัดส่วนที่ต่ำกว่าครัวเรือนที่ต้องพึ่งพาน้ำฝน ผลการศึกษาที่ได้จากสมการถดถอยแสดงให้เห็นว่าการเพิ่มขึ้นของขนาดครัวเรือนจะเพิ่มระดับความยากจนอย่างมีนัยสำคัญ แต่สามารถลดระดับความยากจนดังกล่าวได้ด้วยการเปลี่ยนมาเพาะปลูกภายใต้การชลประทานแทนการพึ่งพาน้ำฝน การเพิ่มงานในฟาร์ม และการเพิ่มปริมาณการเพาะปลูกข้าว


**คำสำคัญ:** ประเทศสาธารณรัฐแห่งสหภาพพม่า ความยากจน การชลประทาน การพึ่งพาน้ำฝน ระบบนิเวศ

## INTRODUCTION

Myanmar is an agricultural country, with a population in 2008 of over 56 million, growing at an annual rate of 2.02 percent. Being an agricultural country, water to support irritation water has always been the governments major thrust in crop production since before independence in 1984. It was found that

Department of Agricultural Resources and Economics, Faculty of Economics, Kasetsart University, Bangkok 10900, Thailand.
* Corresponding author, email: fecochs@ku.ac.th

from 1988/89 to 2007/08, 200 irrigation works had been completed that had benefited about 1,068,544 hectares. Irrigation works used weirs, tanks, sluice gates, pumps, dams and flumes, amongst other methods (MOAI, 2008).

The building of dams and canals and other works to support the supply of irrigation water to crops has resulted in two ecosystems: an irrigated ecosystem, where irrigation has been applied; and a rainfed ecosystem, where no apparent irrigation support has occurred. Changing the ecosystem from rainfed to irrigated could also change the existing farming, as well as non farming activities. Any change in the farm households due to changes in ecosystems would impact finally on their earnings. Needless to say, income from crop production was expected to increase due to irrigation. Many crops, especially rice, that need a good supply of water throughout their growing season would benefit the most from irrigation.

Nautrally, the "construction of dams and expansion of irrigation canals" was one of the strategies of the Ministry of Agriculture to increase rice production (MAS, 1997). A substantial increase in the sown area and the yield of rice and other crops under irrigated ecosystems has shown the success of irrigation works on crop production (DAP, 2007-2008). There is no doubt that the income from these crops would have a significant impact on farm income. Therefore, the current study focused mainly on farm crops, especially rice, in the estimation of factors affecting poverty.

As poverty has always been expected among farm households with different earnings, it should be beneficial to investigate whether the irrigation infrastructure affects poverty levels, by comparing households in areas with different ecosystems, that is, rainfed or irrigated ecosystems.

Hussain and Hanjra (2004) summarized their findings on inequality and poverty among Asian countries as follows: "Income in irrigated settings is higher than in the rainfed, and a 50 percent point gap is not uncommon; the studies unfailingly document evidence of lower poverty rates in irrigated than rainfed environments finding poverty head count ranging from 18 to 53 percent in irrigated and from 21 to 66 percent in rainfed settings. Poverty incidence is 20-30 percent lower in most irrigated settings compared to that in rainfed settings". Therefore, the poverty levels, among Asian countries in general, were lower in irrigated ecosystems than in rainfed ecosystems.

In Myanmar, one of the findings most related to this study is Garcia *et al.* (2000), who found that the poor population in irrigated villages (35%) was higher than that in rainfed villages (21%). The relationship between rice growing and poverty incidence, although non-significant, was such that an increase in rice production with the help of irrigation (MV*IRR = interaction between modern variety with irrigation) could lead to an increase in the probability of the household being poor.

Another related finding (Okamoto *et al.*, 2003) tried to investigate the determinants of income disparity across regions and among households in rural Myanmar. It was found that farming income was lower for farmers and villages with more emphasis on a paddy-based, irrigated cropping system than others. They also found that the highest percentage of poor people was observed among irrigated households.

Therefore, these two findings in Myanmar disagreed with the general findings among Asian countries (Hussain and Hanjra, 2004) with poverty incidence studied in Myanmar being higher amongst irrigated households, while in general, in Asian countries, poverty incidence was lower among irrigated households.

The current study, based on poverty information from households under different ecosystems in Central Myanmar, aimed to produce additional information to clarify whether poverty incidence occurred mainly due to differences in the ecosystems. Assuming that irrigation could increase rice production, the hypothesis of the current study was: "An increase in rice growing can reduce poverty incidence among farm households during 2008".

## OBJECTIVES

1. To measure the incidence, severity and intensity of poverty among farm households.
2. To identify factors affecting poverty.

## POVERTY MEASURES

A poverty line must be defined before measuring poverty. As there was no official information on poverty in the study region in Myanmar, a relative poverty line was defined using the mean income calculated for each ecosystem in the study region (FAO, 2005). Therefore, an individual or household with income at or below the mean income of the same community would be considered poor.

**Foster, Greer and Thorbeck (FGT) Index**

The Foster-Greer-Thorbecke metric or FGT (Foster *et al.*, 1984) is a generalized measure of poverty within an economy. It combines information on the extent of poverty (as measured by the head count ratio), the intensity of poverty (as measured by the total poverty gap) and inequality among the poor (as measured by the Gini and the coefficient of variation for the poor).

The formula for the FTG is given by Equation 1:

$$\mathrm{FGT}_{\alpha} = \frac{1}{\mathrm{N}} \sum_{i=1}^{\mathrm{H}} \left( \frac{z - y_i}{z} \right)^{\alpha} \qquad (1)$$

where, z is an agreed poverty line (for example, kyats per person per day was used as the relative poverty line in the current study), *N* is the number of people in an economy, *H* is the number of poor (those with incomes at or below z), $y_i$ are individual incomes and $\alpha$ is a "sensitivity" parameter. If $\alpha$ is low, then the FGT metric weights all the individuals with incomes below z as roughly the same. If $\alpha$ is high, those with the lowest incomes (the most below *z*) are given more weight in the measure. The higher the FGT statistic, the more poverty there is in an economy. The incidence (headcount ratio), the intensity or depth (poverty gap ratio) and the severity (squared poverty gap ratio) are calculated at $\alpha = 0$, $\alpha = 1$ and $\alpha = 2$, respectively.

**Probit regression**

Based on standard econometric theory, in a regression analysis, if the dependent variable is a dichotomous dummy variable, then a standard linear probability model will have at least two imperfections. Firstly, the results will not be restricted to the two possibilities of the dichotomous variable, namely 1 and 0, but instead may be in between, less, or more, when in fact these are not possible outcomes. Secondly, the residual from such an equation, (which Moore (1997) defined as the difference between the observed value of the response variable and the value predicted by the regression line) would be heteroskedastic (Berndt, 1991). Heteroskedasticity denotes random variables in the series that have changing (nonconstant) variances (Wikipedia, 2004).

To counter these effects, probit models can be applied to permit the use of both categorical and continuous independent variables in conjunction with a categorical dependent variable. The probit model is a nonlinear model that is used to estimate models with binary dependent variables. The predicted probabilities of the probit model will lie in the range (0,1) as long as the values of the independent variables are chosen between the relevant ranges (Zillante, 2003).

Probit coefficients are not straightforward to interpret, because they are not equal to a linear change in the dependent variable, but rather they are equal to the effect of the independent variable on the z scores of the dependent variable. It is well known that parameter estimates from discrete choice models, such as probit and logit, must be transformed to yield estimates of the marginal effects - that is, the change in predicted probability associated with changes in the explanatory variables (Greene, 2003). The marginal effects are nonlinear functions of the parameter estimates and the levels of the explanatory variables, so generally, they cannot be inferred directly from the parameter estimates. Marginal effects are popular in some disciplines (for example economics) because they often provide a good approximation to the amount of change in, say, y, that will be produced by a one unit change in, say, x.

The first step in this simplification is to center all continuous variables at the desired reference point. The most commonly chosen reference point for calculating marginal effects in models with non-linear explanatory variables is at the variable means (Anderson and Newell, 2003). In the current study, the reference point for calculating marginal effects of the independent variables was chosen as the means of the respective variables (Table 5).

The predicted probability from a binary choice model (Anderson *et al.*, 2003) is given by $E[y|x] = F(\beta' x)$, where y is a choice variable, **x** is a vector of explanatory variables, $\beta$ is a vector of parameter estimates, and $F$ is an assumed cumulative distribution function. Assuming $F$ is the standard normal distribution, ($\phi$) produces the probit model, the marginal effects for continuous variables (i.e., the marginal changes in expected probability $\partial E[y] / \partial x$) are equal to $\partial E[y|x] / \partial x = f(\beta' x)\ \beta$, where $f$ is the corresponding probability density function.

For the probit model, $f$ is given by $\phi$, the standard normal density function, where

$$\phi(\beta' x) = \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{1}{2}(\beta' x)^2\right). \qquad (2)$$

The density function $f(\beta' x)$ can therefore, be thought of as a scale factor that translates raw parameter estimates into marginal effects. With all continuous variables normalized to equal zero at the desired reference point, ($\beta' x$) simplifies to $c$ and $f(\beta' x)$ simplifies to $f(c)$, where $c$ is the estimated constant term. As $c$ becomes increasingly positive, $F(c)$ approaches 1, $f(c)$ approaches zero, and therefore, the marginal effects approach zero. Similarly, as $c$ becomes increasingly negative, $F(c)$ approaches 0, and $f(c)$ and the marginal effects again approach 0. The parameter vector $\beta$ can be converted to its associated marginal effects by multiplying by the value of $f(c)$ for the estimated value of $c$. Because both distributions are symmetric, $f(-c) = f(c)$, and the predicted probability at $-c$ is given by $1-F(c)$.

The discrete effect of a dummy variable is found by taking the difference of the predicted probability with and without that dummy variable equal to one. Given the normalizations described above, this results in a simple relationship for the discrete probability effect of a dummy variable (Equation 3):

$$E[y|d = 1] - E[y|d = 0] = F(c + d) - F(c), \qquad (3)$$

where, $d$ is the estimated parameter for the dummy variable.

As $c$ becomes increasingly positive, both the first and second terms of this expression approach 1, so that the net effect of the dummy variable approaches zero.

In order to determine factors contributing significantly to poverty incidence in the study area during 2008, a probit regression model was developed related to the hypothesis, "An increase in rice growing can reduce poverty" (Equation 4).

$$POVERTY = a_0 + a_1 HHSIZE + a_2 MALE + a_3 FEMALE + a_4 FJOB + a_5 EHHH + a_6 RICE + a_6 IRHH + U \qquad (4)$$

where, $a_{0,..,}a_6$ refer to the coefficients of the independent variables and U is the error term.

POVERTY is the response, binary and dummy variable coded with zeros and ones. POVERTY is equal to 1 when the individual household has working members each earning below the relative poverty line, while otherwise, it is 0. Besides rice growing, other predictor variables are also added to estimate factors contributing to poverty. The explanatory variables used in the model were: a) HHSIZE (household size); b) MALE (number of male workers in the household); (c) FEMALE (number of female workers in the household); (d) FJOB (household with over 50 percent of workers engaged in farm-jobs); (e) EHHH (years of schooling of the household head); (f) RICE (growing area in acres of rice) and IRHH (household under irrigated ecosystem).

**Data**

The data for this study was taken from four selected villages in the Leiway township in central Myanmar during 2008. To represent the diversity of the ecosystems, the availability of irrigation facilities was the first priority to be considered in selecting the sample villages. In total 370 households, with 185 households under irrigated ecosystems and 185 households under rainfed ecosystems, were surveyed during 2008.

The characteristics and limitations of human resources were identified by analyzing the sample households with regard to the respondents' age, sex, years of schooling, occupation of the household members, land ownership, and farming or non-farming activities to determine the quality of farm households. In choosing the ecosystems, and in defining the household characteristics and income sources, the following criteria were used (Tables 1, 2 and 3).

**Irrigated ecosystem:** an environmental unit, to which irrigation systems, whether artificial or natural, are applied.

**Rainfed ecosystem:** an environmental unit, to which no apparent irrigation system, whether artificial or natural, is applied.

**Household:** a person or a group of people living in the same residence. Thus, a household in this study was composed of one or more household members (defined below).

**Household members:** To allow the determination of income, household members included any person or persons, whether living in or outside the residence who shared earnings or consumption

**Table 1** Demographic characteristics of households, 2008

| Characteristics | Sample size | Household size | % Male in Household | % Females in household | % Male workers in the household | % Female workers in the household | Average year of schooling of household head |
|---|---|---|---|---|---|---|---|
| Ecosystem | | | | | | | |
| Irrigated | 185.00 | 6.40 | 51.50 | 48.50 | 51.50 | 50.00 | 6.50 |
| Rainfed | 185.00 | 6.65 | 50.00 | 50.00 | 48.50 | 50.00 | 6.00 |

**Source:** Calculated based on survey data

**Table 2** Characteristics of rice farming by ecosystem, 2008

| | Total land area (acres) | Rice sown (acres) | Other crops sown (acres) | Rice cropping intensity (%) | Rice yield (basket/acre) | Average total cost (kyats/acre) | Average net return(kyats/acre) |
|---|---|---|---|---|---|---|---|
| Ecosystem | | | | | | | |
| Irrigated | 467.00 | 348.00 | 645.00 | 74.00 | 77.50 | 98,585 | 106,823.50 |
| Rainfed | 528.00 | 361.00 | 698.00 | 68.00 | 52.00 | 94,619 | 44,697.50 |

**Note:** The number of sown acres was obtained by multiplying the acres sown and the number of crops grown during 2008. For example, if rice was grown two times on one acre of land during 2008, it would be counted as two acres of rice for that year.

**Source:** Calculated based on survey data

or both, within a household, and thus, affected the household income.

**Farm households:** simply refers to households within the farming villages, because it was difficult to separate the households that were totally free from farming activities, but were part of the farming villages in this study.

**Income:** the sum of all the wages, salaries, profits, interest payments, rents and other forms of earning received during 2008.

**Household income:** the sum of all the income earned by a household during the crop year 2008. It was composed of two sources: (a) income from agriculture and (b) income from non-agricultural activities.

**Agricultural income:** income from **farm-jobs**: (a) farm/garden, (b) farm labor, (c) animal husbandry and (d) forestry.

**Farm/garden income:** all income from farm crops: (a) rice crops, (b) blackgram crops and (c) other crops in general.

**Farm labor income:** all the wages and salaries earned from working on the farm.

**Animal husbandry income:** all the income derived from livestock.

**Forestry income:** the sum of all the income earned from forestry work.

**Non-agricultural income:** the sum of all the income derived from work related to **non-farm jobs**: (1) industry, (2) trading/shopkeeping, (3) transportation, (4) construction, (5) rental service, (6) personal service and (7) government service**.**

**Table 3** Occupational distribution and household income distribution by ecosystem, 2008

| | Dependents | | | | Agricultural workers/income | | | | | Non-agricultural labors/income | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Minors | Students | Housewives | Others* | Rice | Non-rice | Livestock | Farm (field) workers | Forestry workers | Industry | Transporters | Traders/shopkeepers | Construction workers | Rental service | Personal | Government workers | |
| **Occupational distribution by ecosystem (%)** | | | | | | | | | | | | | | | | | |
| Irrigated | 9.70 | 17.05 | 2.25 | 4.00 | - | - | - | 28.90 | 3.60 | 4.85 | 2.60 | 4.30 | 5.50 | 2.50 | 10.35 | 4.40 | 100.00 |
| Rainfed | 8.8 | 15.25 | 5.30 | 7.25 | - | - | - | 29.35 | 9.95 | 2.55 | 2.30 | 5.60 | 3.50 | 1.70 | 4.95 | 3.50 | 100.00 |
| **Household income distribution by ecosystem (%)** | | | | | | | | | | | | | | | | | |
| Irrigated | - | - | - | - | 10.50 | 9.50 | 5.00 | 18.00 | 4.50 | 6.00 | 3.50 | 5.50 | 8.00 | 8.00 | 13.00 | 8.50 | 100.00 |
| Rainfed | - | - | - | - | 7.00 | 11.50 | 6.00 | 23.50 | 15.50 | 3.50 | 3.50 | 8.50 | 5.00 | 5.00 | 6.00 | 5.00 | 100.00 |

**Notes:** *Others refers to those who are adults, but not working nor earning income, such as old people, disabled people etc.
**Source:** Calculated based on survey data

## RESULTS AND DISCUSSION

### Relative poverty lines and poverty indices

Although most studies use a percentage (mostly 50% or less, but not usually the whole 100%) of the means or median of family income to define a relative poverty line (Schelzig, 2005), for this study, the full average household income was considered appropriate as a relative poverty line for the households under each ecosystem. The average individual income (kyats/person/day) from each ecosystem was found to be approximately 1,000 kyats, which at the time of this study was approximately equal to USD 1. (USD 1/day, adjusted for purchasing power parity, is the most commonly used standard to identify the poverty line for developing countries and is used by the World Bank, (World Bank, 2008)). In this study, households with per capita income lower than the mean income (the relative poverty line) were considered poor.

Table 4 shows that the relative poverty line for households under an irrigated ecosystem was 986 kyats per day per person and for houeholds in rainfed villages was 855 kyats per day per person, during 2008 cropping year. Thus, the average daily income of people from irrigated households was 131 kyats higher than that for rainfed households.

Even though the relative poverty line for irrigated households was higher than that for rainfed households, the percentage of households earning below the relative poverty line (mean per capita income per day) was found to be lower among irrigated households than among rainfed households, because the gap between the richest and the poorest in the irrigated ecosystems was lower than in the rainfed ecosystems. The distribution of income, shown by quintiles in Table 4, indicates that the richest earners (Quintile 5) earned 13.1497 times more than the poorest earners (Quintile 1) in the irrigated ecosystems, while the richest earned 41.3852 times higher than the poorest in the rainfed ecosystems. Therefore, the income gap between the richest (Quintile 5) and the poorest (Quintile 1) among irrigated households was 3.147 (41.3852/ 13.1497) times lower than among rainfed households. As a result, the percentage of households with per capita income per day below the relative poverty line was found to be lower among irrigated households than among rainfed households.

Table 4 also shows the poverty indices by

**Table 4** Distribution of income by quintiles, relative poverty lines and poverty indices, 2008

| Ecosystems | Irrigated | Rainfed |
|---|---|---|
| Mean per capita income (kyats/person/day) used as relative poverty line | 986.0000 | 855.0000 |
| Income distribution by quintile groups (%) | | |
| Quintile 1 | 4.6100 | 1.3500 |
| Quintile 2 | 6.6100 | 5.9200 |
| Quintile 3 | 8.7800 | 9.0700 |
| Quintile 4 | 19.3800 | 27.7900 |
| Quintile 5 | 60.6200 | 55.8700 |
| Total | 100.0000 | 10000 |
| Quintile 5/Quintile 1 | 13.1497 | 41.3852 |
| Poverty indices | | |
| Head count ratio | 0.5246 | 0.6395 |
| Poverty gap ratio | 0.1123 | 0.1467 |
| Squared poverty gap ratio | 0.0305 | 0.0786 |

**Source:** Calculated based on survey data

head count ratio, poverty gap ratio and squared poverty gap ratio. The percentage of poor households with per capita income lower than the relative poverty line was 52.64 percent among irrigated households and 63.95 percent among rainfed households. Therefore, the poverty incidence shown by head count ratio for irrigated households was 11.49 percent (63.95% minus 52.64%) lower than that for rainfed households. The depth or intensity of poverty, that is, the mean distance separating the population from the poverty line (with the non-poor being given a distance of zero), expressed as a percentage of the poverty line, was lower for irrigated households (11.23%) than for rainfed households (14.67%). Therefore, the total amount of income that would be needed to raise the poor from their present incomes to the poverty line was lower for irrigated households than for rainfed households. The poverty gap ratio ignores the variations in the distribution of income amongst the poor, since the gap is an average. This can be rectified by squaring the poverty gap, which provides the statistical second moment of the distribution - its variance, where the first moment is the average. Squaring individual poverty gaps means that the larger gaps count for more than the smaller gaps, and hence, the measure captures the severity of poverty in a population. The severity of poverty, as measured by the squared poverty gap ratio, was also found to be lower in irrigated ecosystems than in rainfed ecosystems (Table 4).

**Factors contributing to poverty incidence**

The interpretation of the coefficients in a probit regression is not as straightforward as the interpretation of coefficients in a linear regression or logit regression. A further calculation, such as the marginal effects at a specific value (usually the means) of the independent variables, is necessary to express how much the value of the dependent variable can be changed by a unit change in the factor affecting it.

The estimated coefficients and marginal or discrete effects of independent variables were obtained using the probit and dprobit commands in STATA (Corcoran, 2002).

In Table 5, the variables contributing to poverty incidence significantly at the .01 level were HHSIZE, FJOB, EHHH, RICE and IRHH. With the exception of HHSIZE, the other variables had a negative sign, indicating that an increase in these negative-signed variables would help the households change from being poor. HHSIZE with a positive sign indicated that the larger the household size (the number of people in the household), the more mouths to feed and thus the greater probability of the household being poor. The FEMALE parameter, significant at the .05 level with a negative sign, showed there was a more important role for female workers in poverty reduction than male workers, (the MALE parameter) in the family. Differences in the role of gender in poverty reduction could be related to farm-jobs. For example, females were most in demand in the study area as farm labor for rice transplantation (by hand), weeding (by hand), and cleaning and drying the harvested rice, etc.

Table 5 also shows that any additional unit (calculated at the means of independent variables) of HHSIZE would increase the probability of a household being poor by 7.97 percent, while the probability of the household being poor would be reduced by FEMALE (9.59%), FJOB (18.55%), EHHH (3.55%), RICE (17.03%) and IRHH (17.45%), respectively.

Therefore, with each additional unit, FJOB (households having workers mostly engaged in farm-jobs) could reduce the probability of poverty incidence by the highest percentage (18.55%), followed by the IRHH, RICE, FEMALE, and EHHH factors in decreasing order, respectively.

## CONCLUSION

Poverty among farm villages has been in question since before independence in 1948, when irrigation was supported to increase crop production,

**Table 5** Estimated coefficients of the poverty model for poverty, 2008

| POVERTY model parameter | | Coefficient[a] | z-value[b] | dF/dx[c] |
|---|---|---|---|---|
| CONSTANT | ** | 1.5349 | 3.6501 | |
| HHSIZE | ** | 0.2069 | 3.2444 | 0.0797 |
| MALE | | -0.2019 | -1.5944 | -0.0777 |
| FEMALE | * | -0.2490 | -2.2026 | -0.0959 |
| FJOB | ** | -0.4855 | -3.1797 | -0.1855 |
| EHHH | ** | -0.0921 | -3.4789 | -0.0355 |
| RICE | ** | -0.4423 | -6.9340 | -0.1703 |
| IRHH | ** | -0.4570 | -3.0994 | -0.1745 |
| Number of observations | | | | 370.0000 |
| Wald $Chi^2(7)$ | | | | 97.1900 |
| Prob > $Chi^2$ | | | | 0.0000 |
| Pseudo $R^2$ | | | | 0.2793 |
| Log pseudolikelihood | | | | 181.0842 |

**Note:** * and ** indicate significance at 5% and 1% levels, respectively.
The [a] and [c] coefficients and dF/dx were calculated using the probit and dprobit command in STATA.
[b] Robust standard errors for coefficients and dF/dx can be obtained by dividing each by its z-value, respectively. dF/dx calculated at the means of independent variables gives the marginal effect of a small change in each continuous independent variable and the discrete effect in the probability when the dummy variable changes from 0 to 1.

especially rice. By using the survey data from farm villages in Central Myanmar during the 2008 cropping year, the current study investigated whether poverty incidence among farm households was mainly caused by the differences in ecosystems. Assuming that poverty existed among the farm households and also assuming that irrigation could increase rice production, the study tried to prove the hypothesis that "An increase in rice growing can reduce poverty incidence among farm households during 2008". There were several conclusions regarding the impact on poverty.

1) The mean per capita income used as a relative poverty line for irrigated households was higher than for rainfed households, indicating that the income from irrigated households was greater than for rainfed ones.

2) The head count ratio showed that the percentage of poor households was *lower* in irrigated villages (52.46%) than in rainfed villages (63.39%).

3) Not only the head count ratio, but also other poverty indices, namely the poverty gap ratio and the squared poverty gap ratio, were *lower* among irrigated households than among rainfed households, indicating that poverty became severe as the gaps became larger in the rainfed ecosystems. This finding was the same as the general finding among other studies in Asian countries (Hussain and Hanjra, 2004), but opposite to the poverty investigations in some villages in Mynamar (Garcia *et al.*, 2000; Okamoto *et al.*, 2003), where poverty incidence in Myanmar was higher among the irrigated households, while generally in Asian countries it was lower among irrigated households.

The probit regression results showed that a larger household size would increase the probability of the household being poor. On the other hand, the probability of poverty incidence would be reduced significantly as the number of farm-job workers, especially females, within the household increased, the household location changed from a rainfed to an irrigated environment, the rice growing area (in acres) increased, and the number of years of schooling of the household head increased. The finding on the relationship between rice and poverty incidence was opposite to previous findings (Garcia *et al.*, 2000), as these previous studies observed that an increase in rice growing (when modern varieties were first introduced, together with irrigation and farmers were supposedly not ready to adopt the change in technology at the time of the farm survey in 1996) had the tendency to not reduce, but to increase the probability of a farm household being poor. Therefore, based on the current study, it could be concluded that poverty incidence among farm households was caused mainly by the differences in ecosystems, where households in irrigated ecosystems suffered less poverty problems than households under rainfed ecosystems, during 2008. The finding also confirmed the hypothesis made for this study that "An increase in rice growing can reduce poverty incidence among farm households during 2008."

## RECOMMENDATION

The households in the study region should be made aware of the fact that they may face greater poverty as the number of family members in each household increases. Being aware of the positive relationship between household size and poverty incidence, the households may find ways to reduce poverty caused by the increase in population within the household. It should be noted that the level of education of the household head played a significant role in poverty reduction, as poverty incidence in the household reduced as the education level of the household head increased.

As a greater number of workers employed on farm jobs can reduce the poverty incidence more than an increase in the number of workers in non-farm jobs in the study region, more farm-jobs opportunities should be created not only in rice growing, but also in other possible kinds of farming activity. Rice farming will provide more farm jobs for female workers, due to the nature of work requirements in the study region, while the demand for male workers will increase by creating other types of farming than rice farming.

Irrigation should be continued to existing irrigated villages while, at the same time, it should also be extended to rainfed villages, in order to reduce the poverty incidence among farm households there, by increasing farm jobs, by changing the ecosystems from rainfed ecosystems to irrigated ones, and especially by growing more rice, and thus, feeding the increasing population in each household in the future.

## LITERATURE CITED


Anderson, S. and R. Newell. 2003. "Simplified Marginal Effects in Discrete Choice Models." *Discussion Paper*, 81(3): 321-326.

Berndt, E.R. 1991. *The Practice of Econometrics: Classic and Contemporary*. Reading: Addison Wesley Publishing Company, Inc.

Corcoran, S. P. 2002. *STATA: An Introduction with Applied Econometric Applications*, University of Maryland. Retrieved February 2, 2010 from: http://www.nd.edu/~wevans1/ecoe60303/jpsm/stata_book_ maryland2.pdf

DAP. 2007 and 2008. *Myanmar Agriculture at a Glance*. Department of Agricultural Planning, Ministry of Agriculture and Irrigation, the Government of the Union of Myanmar, Yangon, Myanmar.

FAO . 2005. *Impacts of Policies on Poverty, Relative Poverty Lines*, EASYPol, Module 006. Food and Agriculture Organization of the United Nations. Retrieved January 1, 2010 from: http:/ /www.fao. org/docs/up/easypol/317/rel_pov_li nes_006EN.pdf

Foster, F., J. Greer, and E. Thorbecke. 1984. "A Class of Decomposable Poverty Measures." *Econometrica*, 52(3): 761-66.

Garcia, Y.T., A.G. Garcia, M. Oo, and M. Hossain. 2000. "Income Distribution and Poverty in Irrigated and Rainfed Ecosystems: The Myanmar Case." *Economic and Political Weekly*, 35(52/ 53):4670-4676.

Greene, W.H. 2003. *Econometric Analysis*, 5th ed. New Jersey. Prentice Hall.

Hussain, I. and M. A. Hanjra. 2004. *Irrigation and Poverty Alleviation: Review of the Empirical Evidence.* Published online in Wiley InterScience. International Water Management Institute, Colombo, Sri Lanka.

MAS. 1997. *Myanmar Agriculture in Progress.* Myanmar Agricultural Service, Ministry of Agriculture and Irrigation, the Government of the Union of Myanmar, Yangon, Myanmar.

MOAI. 2008. *Information on Myanmar Agriculture*, Ministry of Agriculture and Irrigation, the Government of the Union of Myanmar, Yangon, Myanmar.

Moore, D.S. 1997. *The Basic Practice of Statistics* New York: W.H. Freeman and Company.

Okamoto, I., K. Kurita, T. Kurosaki and K. Fujita. 2003. *Rich Periphery, Poor Center:* Myanmar's Rural Economy under Partial Transition to Market Economy (This version, October, 2003).

Schelzig, K. 2005. *Poverty in the Philipines: Income, Assets, and Access.* Retrieved February 4, 2010 from: http://www.adb.org/Documents/Books/Poverty-in-the-Philippines/chap3.pdf.

Wikipedia, The Free Encyclopedia. 2004. *Heteroskedasticity.* Retrieved January 14, 2010 from: http//www.encyclopedia.thefreedictionary.com/Heteroskedasticity.

World Bank. 2008. *Poverty Facts and Stats. World Bank Development Indicators, 2008.* Retrieved February 5, 2010 from: http://www.globalissues.org/article/26/po verty-facts-and-stats.

Zillante, A. 2003. *Linear Probability and Probit Models.* Retrieved January 10, 2010 from: http//wwwgarnet.acns.fsu.edu/~alz9794/metricch11.pdf.