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Development of Energy Saving Multi-Fuel Cooking Stove

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ABSTRACT

The Philippines is typical of many developing countries where the majority of the population has low income. With the present economic crisis happening due to the increase of oil prices, housewives are very much worried in budgeting family expenditures. They find hard to budget the day to day needs of the family. Thus, the need to design and develop a low consuming, multiple feed cooking stove, yet comparably performs with liquefied petroleum gas (LPG), kerosene and electric stove, would somehow ease the day to day expenditure. Energy Saver Multi-Fed Cooking Stove was structured and made up of scrap iron bars sheet and a pipe welded together. It has a chimney and an ash tray. Multi- Fuel in the sense that it can be fuelled with firewood, charcoal like corn cobs, tobacco stalks, and others which were usually burned when the farmers lack knowledge in making use into fertilizer. Qualitative testing was done in cooking different food was done to identify the cooking fuel consumption. Using firewood is more economical in cooking with rice, vegetable dishes, boiling of fruits and root crops. While cooking meat and frying fish, charcoal is also more economical. In cooking different foods, it is significantly different from one another of fuel material. This implies that all the fuel materials are significantly different in terms of cooking different foods. Furthermore, cooking different foods is significantly different in all cooking stoves like LPG, kerosene, clay and electric stove.

Keywords **-** Conserve Energy Develop Multi-feed Cooking Stove Vigan City. Ilocos Sur, Philippines

INTRODUCTION

The Philippines is a nation with more than 7,000 islands. The larger islands are mountainous. Much of the land is clad in the forest where bamboo and huge varieties of trees are grown. Unfortunately, the country's rich resources have been restlessly plundered. Logging companies have filled millions with hardwood trees for fire wood causing problems with soil erosion and flood that destroy the environment and farmlands.

About half of the population earn their living by farming, growing rice, sugarcane, pineapples, bananas, coconut, corn and tobacco. The economy is based mainly on agriculture and timber production.

The Philippines is typical of many developing countries where the majority of the population has low income, and the middle class is small. Survey in 1995 there were 12,821,000 households in the Philippines with 57% in the lowest income bracket (less than 5000 pesos/month). Unfortunately, household survey combines 57% of the population into one income category, limiting a more detailed understanding of fuel choice relative to income level. Nonetheless, the household survey provides some valuable insights into the fuel choices made by the general populace. (Samson R., 2000)

Currently, the fuel requirement of 55% of the rural poor is supplied by firewood, with another 25% of the requirement through biomass residues as the Philippines landscape is becoming increasingly agricultural residues for their fuel supply instead of firewood and charcoal. Biomass residues seem to be quite popular across all income bracket in rural areas due to their availability.

Pelletized biomass enables more efficient combustion relative to other biomass forms and makes fuel convenient to transport and store for consumers. Significant improvement in pelleting technologies (Samson, 2000) and small cook stove suitable for burning these fuels are under development (Reed & Larson, 1996).

For this reason, the researchers conceived to design and develop multi-fuel cooking stove to help minimize cutting down of trees for firewood. Multiple fuel in the sense that it can be fuelled with a firewood, charcoal, farm and environmental wastes like corncobs and tobacco stalks which are usually burned off when farmers lack knowledge in making these into organic fertilizer.

With the present economic crisis happening in the country, due to the fact increase of oil prices, this technology will help the people every much. Housewives

are very much worried in budgeting the family's expenditures. They find hard to budget the day to day needs of the family. Thus, the need to design and develop a low consuming, multiple feed cooking stove, yet comparably performs with LPG, kerosene and electric stove, would somehow ease the day to day expenditures.

In highly technological society where mass production provides an unending supply of identical products, there is a genuine pleasure in creating something that is one of a kind. It is for this reason that the researchers, who are craftsmen by vocation, want to design and develop a Bio mass Cooking Stove. Moreover, the researchers, who are also technology educators, believe that the educational system is geared toward technology.

FRAMEWORK

Household surveys were conducted in the Philippines to explore fuel choice in 1989, and in 1995 (Samson et al. 2000), the surveys suggest that increasing agricultural land base, ongoing deforestation of the uplands, and population urbanization have an important influence on household fuel use pattern. The surveys indicate and increasing trend of LPG users and LPG consumption, and an overall decline in biomass use. Kerosene consumption also rose between the two surveys, although the number of users remained somewhat constant, and the use of kerosene for direct cooking applications comprised only about 1/3rd of its total use. In the biomass sector, fuel wood use declined by 51% and biomass residue use increased by 43%. Overall biomass use decreased by 15% on a tonnage basis over the 6 years. The widespread availability of electricity in the Philippines appears to have had minimal impact in cooking fuel choice to date.

During the 6 year period, charcoal consumption dropped dramatically by 51 percent, again explain by Samson et.al. Charcoal use is becoming less common as a primary cooking fuel, mainly for grilling. According to the surveys, approximately 90.6% biomass residues used for fuel are self-collected or gathered the annual consumption of biomass residues per capital rose from 46.4 kg (1989) to 53.9 kg.

Electricity, LPG, and Kerosene are becoming more popular fuel sources in the Philippines. Between 1989 and 1995 the household utilization and the amount consumed of each of these fuels rose significantly. On a household scale, use of both LPG and Kerosene increased 26% per year between 1989 and 1995.

OBJECTIVES OF THE STUDY

This research work aimed to make the design, fabrication and production of a multi-fuel cooking stove. Further, it sought to provide a locally available technology which will work effectively and efficiently that comparatively performs to LPG, kerosene, clay and electric stove.

The main objectives, the following specific objectives were realized:

1. Fabricate the housing assembly, chimney, feeding spout, ash tray including the charcoal holder and ash screen separator.
2. Test the cooking consumption using firewood charcoal, corncobs and tobacco stalks.
3. Emphasize the economic advantage of the proposed gadget vis-a-vis the LPG, kerosene, clay, and electric stove.

METHODOLOGY

This study used the experimental type of research in three phases:

Phase 1 Design and fabrication of Multi-fuel Cooking Stove.

The research on Multi-Fuel Cooking Stove was conceptualized for cooking food using firewood, charcoal, corncobs, and tobacco stalks. As the working drawing complete, the scrap materials were prepared taken from the junk shops or the market. Such gadget can also be fabricated in rural areas provided a welding machine is available. Upon completion of the gadget, testing was undertaken. Feedbacks from technology adaptors served as refinement for the gadget. Upon completion of the revision, the suggestions and innovations were incorporated into the gadget.

Phase 2 focused on qualitative testing with fuel material to identify cooking consumption using firewood, charcoal, corncobs and tobacco stocks.

Phase 3 dealt on economic comparison of the proposal gadget with the LPG, kerosene, clay and electric stoves.

RESULTS AND DISCUSSION

After several trials and feedback of the technology adaptors, cooking food of ideal size of 6 to 7 members of the family consumption of the energy saver multi-

fed cooking stove is much economical compared with the LPG, kerosene, clay and electric stoves.

Result of qualitative test of different cooked food to identify cooking material average consumption is presented in table 1. It highlights these following observations.

The stove passed through qualitative test with the different fuel materials to identify the cooking consumption using the LPG, kerosene, clay and electric stoves. Below are the results of ANOVA testing for significant difference between and among fuel materials.

Table 1. Average cooking consumption of the multi-fuel cooking

FOOD	FIREWOOD				CHARCOAL				CORNCOBS				TABACCO			
					T	R	I		A	L	S					
	1	2	3	Ave	1	2	3	ave	1	2	3	ave	1	2	3	ave
Rice	.75	.8	.7	.75	.20	.25	.30	.25	1.0	1.25	1.3	1.183	1.5	1.6	1.55	1.55
Vegetable Dishes	.80	.65	.7	.716	.30	.35	.35	.316	1.0	1.3	1.35	1.216	1.6	1.5	1.7	1.6
Meat	1.30	1.4	1.35	1.35	.40	.45	.50	.466	1.50	1.55	1.60	1.55	2.6	2.8	2.75	2.71
Boiling	.50	.60	.55	.55	.20	.25	.25	.23	1.25	1.0	1.3	1.166	1.10	1.20	1.10	1.1
Frying	.50	.40	.45	.45	.15	.18	.17	.166	.75	.65	.70	.70	.50	.45	.55	.516

The table showed that using the multi-fuel stove, cooking with rice, vegetables dishes, boiling of fruits and root crops using firewood is more economical as compared to other fuel materials. While cooking meat and frying fish and meat using charcoal is also more economical.

Table 2. Results of ANOVA testing for significant differences in cooking rice between and among other fuel materials

Source of variation	Degrees of freedom	Sum of squares	Mean of squares	F-computed	f-tabular
Different fuel	3	2.83	0.94	125.33*	4.07
EXPERIMENTAL ERROR	8	0.06	0.0075		
TOTAL	11				

Significant at 0.05 level

In the table, it determines whether in cooking rice there exists a significant difference between and among other fuel materials. The F-ratio of 4.07 is significant at .05 probability level. This implies that all the fuel materials are significantly

different in terms of cooking rice.

Result of scheffe test is significantly different in pairwise mean of all the fuel materials.

Table 3. Result of ANOVA testing for significant

Differences in cooking meat between and among other fuel materials

Source of variation	Degrees of freedom	Sum of squares	Mean of squares	F-computed	f-tabular
Different fuel	3	7.82	2.61	1.044	4.07
EXPERIMENTAL ERROR	8	0.02	0.0025		
TOTAL	11				

Significant at 5 percent level

In the table, it determines whether in cooking meat there exists a significant difference between and among other fuel materials. The F-ratio of 4.07 is significant at .05 probability level. This implies that all the fuel materials are significantly different in terms of cooking meat.

Result of scheffe test reveals a significantly different pair wise mean of all the fuel materials.

Table 4. Result of ANOVA testing for significant Difference in Cooking Vegetables Dishes Between and among other Fuel Materials

Source of variation	Degrees of freedom	Sum of squares	Mean of squares	F-computed	f-tabular
Different fuel	3	2.78	0.93	71.54	4.07
EXPERIMENTAL ERROR	8	0.1	0.013		
TOTAL	11				

Significant at 5 percent level

In the table, there is a significant difference between and among other fuel materials. The F-ratio of 4.07 is a significantly at .05 probability level. This implies that all the fuel materials are significantly different in terms of cooking vegetable

dishes.

Result of scheffe test is significantly different in pair wise mean of all the fuel materials.

Table 5. Result of ANOVA testing for significant difference in frying dishes between and among other fuel materials

Source of variation	Degrees of freedom	Sum of squares	Mean of squares	F-computed	f-tabular
Different fuel	3	0.43	0.14	368.42	4.07
EXPERIMENTAL ERROR	8	0.003	0.00038		
TOTAL	11				

Significant at 5 percent level

There exists a significant difference between and among other fuel materials. The F-ratio of 4.07 is significantly at .05 probability level. This implies that all the fuel materials are significantly different in terms of frying dishes.

Result of scheffe test is significantly different in pairwise mean of all the fuel materials.

Table 6. Results of ANOVA testing for significant difference in boiling fruits or root crops between and among other fuel materials

Source of variation	Degrees of freedom	Sum of squares	Mean of squares	F-computed	f-tabular
Different fuel	3	1.85	0.62	70.45	4.07
EXPERIMENTAL ERROR	8	0.07	0.0088		
TOTAL	11				

Significant at 5 percent level

In the table, there exists a significant difference between and among other fuel materials. The F-ratio of 4.07 is significant at .05 probability level. This implies that all the fuel materials are significantly different in terms of boiling fruits or root crops.

Result of scheffe test is significantly different in pairwise mean of all the fuel materials.

A. **Economic comparison**

The stove also passed through qualitative test with the different expenditures to identify the cooking expenses compared to LPG, kerosene, stove clay stove, and electric stove.

Table 7. Result of ANOVA testing for significant differences in cooking rice between and among other Cooking Stoves

Sources of Variations	Degree of Freedom	Sum of Squares	Mean of Square	F-computed	F-tabular
Different Cooking Stove	4	357.6	89.4	40.64	3.48
Experimental error	10	22	2.2		
Total	14				

Significant at 5% level

The table gleans whether in cooking rice, there is a significant difference between and among other cooking stove. The F-ratio of 3.48 is significant at 0.05 probability level. This implies that all the cooking stoves like electric, clay, LPG stove are significantly different in terms of cooking rice.

The result of scheffe test is significantly different in pairwise mean of all the cooking stove except the clay stove versus ESMC.

Table 8. Result of ANOVA testing for significant differences in cooking meat between and among other cooking stoves

Sources of Variations	Degree of Freedom	Sum of Squares	Mean of Square	F-computed	F-tabular
Different Cooking Stove	4	357.6	89.4	34.38*	3.48
Experimental error	10	26	2.2		
Total	14				

Significant at 5% level

The table showed that cooking meat is significantly different in all of the cooking stoves. Result of scheffe test is significantly different in pairwise mean of all the cooking stove except the clay stove versus ESMC as in cooking with rice.

Table 9. Result of ANOVA testing for significant difference in cooking vegetables Ilocano dishes between and among other cooking stove

Sources of Variations	Degree of Freedom	Sum of Squares	Mean of Square	F-computed	F-tabular
Different Cooking Stove	4	357.6	89.4	34.38*	3.48
Experimental error	10	26	2.2		
Total	14				

Significant at 5% level

The table implies that all the cooking stoves are significantly different in terms of cooking. And when test with scheffe again, significantly different in pairwise mean of all the cooking stove except in the clay stove versus ESMC's which is not significant from one another.

Table 10. Result of ANOVA testing for significant difference in boiling fruits between and among other cooking stoves

Cooking Stove	Average consumption in pesos for the Three Trials				
	Rice	Veg. Dishes	Meat	Boiling	Frying
ESCMS	5	5	10	0.5	3
LPG Stove	18 18 23 17 5				
Kerosine Stove	15	15	20	14	4
Clay Stove	7	7	12	6	4
Electric Stove	13	13	18	12	4

Significant at 5% level

Again, the table implies that all the cooking stoves are significantly different in terms of boiling fruit. Scheffe test is significantly different in all the cooking stoves except the clay stove versus the ESMCs which is found not significant.

Table 11. Result of ANOVA testing for significant difference In Frying between and Among other cooking stove

Sources of Variations	Degree of Freedom	Sum of Squares	Mean of Square	F-computed	F-tabular
Different Cooking Stove	4	320.4	80.1	69.65*	3.48
Experimental error	10	11.5	1.15		
Total	14				

Significant at 5% level

Furthermore, the table shows that all the cooking stoves are significantly different in terms of frying. When test on Scheffe, a significant resulted in pairwise mean of all the cooking stove except ESMCs versus LPG.

Table 12. Result of Three trials in cooking different foods using different cooking stoves

Cooking Stove	Average consumption in pesos for the Three Trials				
	Rice	Veg. Dishes	Meat	Boiling	Frying
ESCMS	5	5	10	0.5	3
LPG Stove	18 18 23 17 5				
Kerosene Stove	15	15	20	14	4
Clay Stove	7	7	12	6	4
Electric Stove	13	13	18	12	4

It can be seen that all cooking stoves when compared to the ESMCS, it is more economical in terms of consumption in cooking different foods.

CONCLUSIONS

The designed cooking stove was structured and made up of scrap iron, G.I. Sheet, bars and pipes welded together. It has a chimney and an ash tray. It can be fuelled firewood, farm waste and others found in the locality.

The stove is more economical in terms of expenses with cooking the different food as compared to LPG, kerosene, electric and clay stove. The designed cooking stove helps minimize in cutting firewood that causes soil erosion and flood that destroys the environment.

RECOMMENDATION

The developed multi-fuel cooking stove should be introduced to the urban and rural areas, for it is more economical compared to other cooking stoves specifically the clay stove.

Farmers must be oriented that their farm wastes will not be thrown to garbage or burned off. When not done for organic fertilizer, they will sell for fuelling the said cooking stove or in similar.

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