

PROFITABILITY ANALYSIS OF MANGO CULTIVATION AND ITS IMPACT ON FARMER'S LIVELIHOOD IN SOME AREAS OF BANGLADESH

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Abstract

The study was carried out to investigate profitability of mango farming and to assess the impact of BARI Aam-3 mango variety production on the farmer's livelihood in four mango growing districts namely Khagrachori, Bandorban, Naogaon, and Satkhira of Bangladesh during February to March, 2018. A total of 128 BARI Aam-3 growers were selected using multi-stage random sampling technique. Descriptive statistics and financial profitability analysis was used to analyze data. The net return for one hectare of mango orchard was Tk. 730233 for 6-7 years of BARI Aam-3 mango orchard. Net present value was estimated to Tk. 444397 for BARI Aam-3 which indicates that mango cultivation fetches higher returns. The estimated benefit cost ratio was 2.01 for BARI Aam-3 which ensures that investment in BARI Aam-3 is feasible for the mango farmers. The BARI Aam-3 mango cultivation was also found to be a profitable enterprise since internal rate of return was very high (83.075%). The results also reveal that human capital increased by 54.34%, 68% and 60.54%; physical capital increased by 48.17%, 58% and 50% as well as social capital increased by 28.50%, 43% and 45.95% of the small, medium and large farmers respectively due to cultivation of BARI Aam-3 mango variety. Therefore, it is highly recommended to spread the information of BARI Aam-3 cultivation as a profitable enterprise among the mango growers throughout the country.

Keywords: Mango, Profitability, Assets, livelihood, Bangladesh.

Introduction

Agriculture is the dominant economic activity in Bangladesh which comprises more than 15% of country's GDP and employs around 43% of labor force (BBS, 2017). Ensuring food and nutritional security and alleviating poverty is the prime concern of the present government. The Sustainable Development Goals (SDG) has reemphasized on the need of building more dependable food security system with increased productivity. Therefore, it is necessary to generate more diversified food with greater shares of fruit production. But production of fruits is still far behind the countries present requirement. About 78gm fruit is available

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per person in Bangladesh whereas 200gm is the daily requirement (BBS, 2017). Among the fruits in Bangladesh banana stands in the top position in terms of area coverage (32%) and production (17%) followed by mango (25% area and 24% production) and pineapple (9% area and 4% production) (BBS, 2016). Mango (*Mangifera indica L.*) is recognized as the one of the choicest and well accepted fruit all over the world due to its attractive color, marvelous flavor, delicious taste and high nutritive value. It is a nutritionally important fruit being a good source of vitamin A, B & C and minerals. Sugar constitutes main bulk of the carbohydrates and most of the soluble solids are found in ripe mango (Ravani and Joshi, 2013; Nigam *et al.*, 2007). Area under mango production is fluctuated over the last decades whereas total production has been increased in Bangladesh. In 2004-05, mango was cultivated in 25055 hectares of land and yield was 26.43 ton/ha (BBS, 2008). Still then area coverage is being increased continuously with an upward movement of total production. In 2015-16, mango acreage was 37823 hectares with the highest level of production (1161685 metric tons) throughout the last decade with average yield of 30.71ton/ha (BBS, 2017). It is grown in most of the districts of Bangladesh. Bangladesh is the world's eighth largest mango producing country as it produces about 1,047,850 tons of mangos every year which accounts for 3.9 percent of the world total mango production (Rahman and Khatun, 2018).

Area under mango production is fluctuated over the last decades whereas total production has been increased in Bangladesh. Figure 1 denotes that in 2004-05, mango was cultivated in 25055 hectares of land and yield was 26.43 ton/ha. Still then area coverage is being increased continuously with an upward movement of total production. In 2015-16, mango acreage was 37823 hectares with the highest level of production throughout the last decade i.e., 1161685 metric tons. The figure also shows that the yield of mango is increasing at an increasing rate during the year 2004-05 to 2014-15.

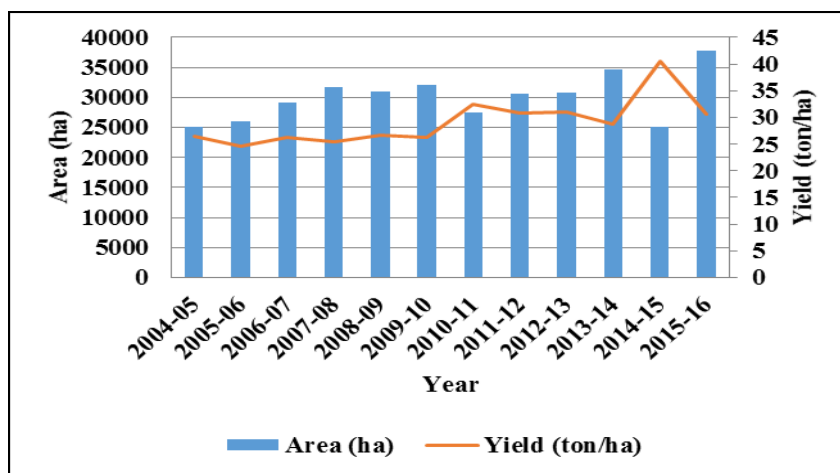


Fig. 1. Area and Yield of Mango Fruits in Bangladesh (Source: Various issues of BBS).

But due to climatic context and soil advantages most of the best variety mango cultivation was limited to north-western and south-western districts of Bangladesh. The main source of income of this region is mango cultivation. With the innovation of modern developed mango variety, it is now cultivated commercially in other districts of Bangladesh. Bangladesh Agricultural Research Institute (BARI) is the leading organization to develop mango variety in Bangladesh. Since 1996 to 2015, it has developed 11 types of improved high yielding mango varieties (Azad *et al.*, 2017).

Among the varieties BARI Aam-3 is an important innovation in Bangladesh. It is a hybrid mango variety, has been developed by crossing between Kiron (female) and Deshari (male) (Hossain *et al.*, 2003). At field level this variety is well known as Amropali or Aam Rupali or Rupali. Mainly it was developed in the Indian Agriculture Research Institute at Pusa, Delhi in 1971 (Wikipedia). Since then this mango has been introduced in the farms and orchards across India. After justifying its suitability in Bangladesh, it was approved for cultivation in 1996 in the name BARI Aam-3. BARI Aam-3 has been demonstrated very rapidly during the last decade. Because the climate and soil of Bangladesh are suitable for high yielding BARI Aam-3 cultivation and farmers get yield within three years of plantation with relatively less efforts. Shiblee (2015) conducted a study on assessing BARI released mango varieties at field level where he concluded that BARI Aam-3 was the best in all the farms under investigation in terms of sale of stions (stock + scion). Its cultivation has brought solvency to many people in Satkhira, Khagrachori, Naogaon and Bandarban districts of Bangladesh. But there is no in depth study on finding out profitability of growing mango specially BARI Aam-3 and its impact on farmer's livelihood in Bangladesh. The farmers need information regarding investment and returns from mango production business. Keeping in view the importance of mango in terms of area and production the present study investigates in determining cost of production and profitability of growing mango orchard. So the specific objectives of the study are:

- i. To evaluate the economic profile of mango growers and
- ii. To assess the assets of livelihood strategies of mango growers

Methodology

Study area selection

A preliminary survey was conducted in Sadar Upazila of Khagrachori district for pre-testing the survey schedule. Based on the preliminary survey, four BARI Aam-3 growing districts namely Khagrachori, Satkhira, Bandarban, and Naogaon were selected and two major BARI Aam-3 growing Upazilas from each district were purposively selected for selecting sample orchards. All the mango growers were randomly stratified into small (≤ 40 trees), medium ($41 \leq 79$ trees) and large (≥ 80 trees).

Sampling technique adopted and way of sample selection

Multi-stage random sampling technique was used to select the required mango growers. A total of 128 mango orchards were randomly selected for the study. The distribution of sample orchards is presented in the following Table 1.

Table 1. Distribution of sample orchards

Location	BARI Aam-3 orchard (No.)				Total
	Up to 1 year	1-3 year	3-5 year	More than 5 year	
1. Khagrachori					
- Khagrachori Sadar Upazila	2	2	2	10	16
- Dighinala Upazila	2	2	2	10	16
2. Bandorbon					
- Bandorban Sadar Upazila	2	2	2	10	16
- Ali Kadam Upazila	2	2	2	10	16
3. Satkhira					
- Satkhira Sadar Upazila	2	2	2	10	16
- Kaliganj Upazila	2	2	2	10	16
4. Naogaon					
- Naogaon Sadar Upazila	2	2	2	10	16
- Sapahar Upazila	2	2	2	10	16
Total	16	16	16	80	128

Study period

Primary data were collected from the respondents by using interview schedule during the month of January to March, 2018.

Analytical Technique

Descriptive Statistics

Descriptive statistics were used to analyze the data by sum, average and percentages.

Statistical technique

Growing fruit trees represent long term investment. Production of mango can be considered as a function of various inputs employed in the process of production. The farmers had to incur cost for different inputs such as human labor, machinery, fertilizer, insecticides etc. for cultivating mango in the orchard. The profitability of mango production was measured on the basis of Gross Return, Gross Margin and Net Return. At the same time capital budgeting was also done

by calculating Net Present Value, Benefit Cost Ratio and Internal Rate of Return of the mango orchard. The discount rate was specified by assuming the opportunity cost of capital which is 12% for most of the developing countries (Gittinger, 1984).

Livelihood analytical technique

Livelihood pattern was measured by presenting the five types of capitals namely human capital, social capital, natural capital, physical capital and financial capital (DFID, 2000) which is known as assets pentagon. A sustainable livelihood is the outcome of inter and intra relationship between the components of these five livelihood assets/capitals. In this study, an attempt was made to measure the changes in assets position of the mango farmers for one year due to cultivation of BARI Aam-3 mango variety.

Results and Discussions

Profitability of BARI Aam-3 Mango Farming

Profit is a basic criterion for selecting an enterprise. The study found that farmer planted 100-120 trees per acre (100 decimal) of land in the sense that after 5-6 years they cut one of every three of the line in order to clear it for air and light. Farmers have the option to do intercrop with BARI Aam-3 mango orchard up to 3-4 years of age. Generally, after 4 years of mango tree farmers did not cultivate any kind of intercrop. The study also found that only 18% of the respondents do intercrop in one or two years in their orchard and they did it with different crops. Due to complexity in accounting costs and return of intercropping, the present study does not cover costs and return of intercropping in determining profitability of BARI Aam-3 mango farming.

It is evident from Table 3 that hired labor ranked the highest variable cost item of BARI Aam-3 mango orchard. The lowest used variable input was manures following by MoP among the chemical fertilizers. The per hectare total cost of BARI Aam-3 mango orchard from the establishment year to two years was estimated to Tk. 104211 where cost of saplings was the major cost item. Insecticides cost was not recorded during this period because there was no problem of insect. For the second section (2-3 years' trees) total cost was Tk. 82524 per hectare and the main component of variable cost was hired labor whereas the second most important one was insecticides. After that total cost was increased in ascending order. Fixed cost does not depend on the level of production. Only three items were considered as fixed cost for the mango orchard viz., family labour, interest on operating capital (IOC) and rental value of land in the study areas as indicating in Table 3. Considering all variable and fixed costs, total cost and net return was determined in the study areas.

Table 3. Average cost of BARI Aam-3 mango cultivation (Tk./ha)

Items	Age of mango tree (year)							All years	% of total
	Up to 2	2-3	3-4	4-5	5-6	6-7			
A. Variable Cost (Tk.)	50717	28307	25324	32331	29455	36072	202205	34.8	
Hired labor	13775	10940	11370	17896	16523	21326	91830	15.8	
Saplings	30245	0	0	0	0	0	30245	5.2	
Manures	630	371	891	704	693	655	3943	0.7	
Fertilizers									
Urea	378	926	573	1853	1890	1853	7473	1.3	
TSP	1638	1606	955	2470	2142	2161	10972	1.9	
MoP	378	926	573	1853	1638	1766	7134	1.2	
Insecticides	0	7904	7639	2737	2641	2594	23515	4.0	
Irrigation	1079	1235	2546	2905	2352	3930	14046	2.4	
Miscellaneous	2594	4399	777	1914	1575	1788	13047	2.2	
B. Fixed cost (Tk.)	53494	54217	55887	63482	73128	79294	379503	65.2	
Family labour	8451	7199	8138	12833	18154	20345	75120	12.9	
Interest on operating capital (Tk.)	3876	5851	6582	9482	13807	17782	57381	9.9	
Rental Value of land (Tk./year)	41167	41167	41167	41167	41167	41167	247002	42.5	
C. Total Cost (A+B) (Tk.)	104211	82524	81212	95813	102583	115365	581708	100.0	

Source: Field Survey, 2018.

Table 4. Profitability of mango variety BARI Aam-3 cultivation

Items	Age of mango tree (year)						All Year
	Up to 2	2-3	3-4	4-5	5-6	6-7	
A. Total cost (Tk./ha)	104211	82524	81212	95813	102583	115365	581708
Variable cost (Tk./ha)	50717	28307	25324	32331	29455	36072	202205
Fixed cost (Tk./ha)	53494	54217	55887	63482	73128	79294	379503
B. Average yield (kg)	--	1578	4889	5512	7080	9586	28645
C. Average price (Tk./kg)	--	45	44	45	45	50	45.8
C. Gross return (Tk./ha)	--	71010	215116	248040	318600	479300	1311941
F. Gross margin (Tk./ha)	-50717	42703	189792	215709	289145	443228	1109736
G. Net return (Tk./ha)	-63291	-11514	133904	152227	216017	363935	730233

Per hectare average return of BARI Aam-3 mango orchards in the study areas are depicted in Table 4. Farmers told that they got fruits just after 2-3 years of plantation and this is unique only for BARI Aam-3 variety. So, gross margin and net return became negative up to 2 years of plant age as total cost was high enough at that time. Then net return increased substantially. Farmer told that in case of BARI Aam-3, fruit yield started decreasing drastically after 15 years of plant age. Per hectare average mango yield was found 5729 kg and gross return and net return was Tk. 1311941 and Tk. 730233 respectively from 2-3 years to 6-7 years of mango orchard.

Capital Budgeting of BARI Aam-3 Mango Orchard

Net present value (NPV): It is evident from Table 5 that NPV of BARI Aam-3 mango orchard is positive and greater than zero. Therefore, the mango production is an acceptance practice and feasible from financial point of view. Further, it also implies that the owner became able to increase his wealth by Tk. 444397 per hectare of mango production at the end of 6-7 years of plants age.

Benefit cost ratio (BCR): BCR was emerged to be 3.03 (Table 5) showing that investment in mango cultivation can be considered substantial and economically justifiable. It indicates that the mango growers earned a gross income of Tk. 2.01 by investing Tk. 1 per one hectare of mango orchard.

Internal rate of return (IRR): IRR was determined by following ‘trial and error’ approach at different discount rates. By using the formula mentioned in the methodology, IRR was calculated and it was 83.075%. It is evident from Table 5 that IRR of BARI Aam-3 mango orchard stood at 83.075% which is sufficiently greater than existing bank interest rate. So, it assures that investing in BARI Aam-3 mango orchard was very much feasible and it ensured a reasonable profit for the investors.

Table 5. Per hectare rate of returns to investment on BARI Aam-3 mango orchard

Year	Gross cost (Tk)	Gross benefit (Tk)	Present worth of gross cost at 12%	Present worth of gross benefit at 12%
0	104211	0	104211	0
1	82524	71010	73682	63402
2	81212	215116	64741	171489
3	95813	248040	68198	176550
4	102583	318600	65193	202476
5	115365	479300	65461	271968
	Total		441487	885885
	NPV		444397	
	BCR		2.01	
	IRR		83.075%	

Impact of BARI Aam-3 mango cultivation on livelihood improvement

Livelihood improvement of a farmer depends on various socioeconomic activities of the farmer as well as society. However, an attempt was made to measure the changes in assets position of the respondent farmers for one year due to cultivation of BARI Aam-3 variety.

Human capital

Appendix Table 1 shows that the access to human capital of small orchard owners increased by 54.34% due to cultivation of BARI Aam-3 especially education and training increased by 72.7% and 81.8% respectively. Appendix Table 1 represents that involvement in medium type BARI Aam-3 mango orchard production increases their access to human capital by 68% of which health and sanitation was increased by 100%. At the same time education and nutrition status of the medium type BARI Aam-3 mango orchard owner increased by 80%. Access to human capital by the large type BARI Aam-3 orchard owner was increased by 60.54% which also represents a good range of improvement in health and sanitation (70.27%), education (72.97%) and nutrition (78.38%).

Social capital

Appendix Table 1 shows mostly a constant situation of the farmer's involvement in the social capital as they are mostly small mango orchard owner and their income may not support to build their strong social position. It shows only 28.8% of their access to social capital has increased. On the other hand, with the increase in the size of the BARI Aam-3 mango orchard farmers' access to social capital has increased slightly by 43.3% and 45.95% for the medium and large mango orchard owner respectively (Appendix Table 1). But in all the three types a positive movement was found in improvement of social respect and women empowerment.

Natural capital

Own cultivable land, cultivable land in lease system, using water (pond) and safe drinking water were increased compare to the other natural capital assets which is represented in Appendix Table. Majority of respondents had constant access to different types of natural capital. Most often some natural capital decrease for the respective respondents.

Physical Capital

The total access to physical capital was increased by 48.17% in case of small mango orchard owner while it was 58% (Appendix Table 1) for medium mango orchard owner and 50% for large mango orchard owner. It means that with the

investment in large size mango orchard brought out more positive output which tends to raise different kinds of physical assets. Number of brick built house was increased. These situations indicate the improvement of household condition of the respondent. The condition of other major components of housing as well as safe drinking water i.e., presence of tube well, electricity and sanitary toilet were also developed considerably. The number of using mobile phone increased tremendously for all the respondents. Some living assets like livestock such as cattle, goat, poultry and duck also were decreasing for the respective respondents. This happened because of lacking livestock grazing land in the study area.

Financial capital

In the case of small mango orchard owner, the status is more or less constant while in case of other two types it shows a gradual increase in all of the items of financial capital. The capital, cash in hand increased by 36.4%, 100% and 78.38% for the small, medium and large mango orchard owner respectively. Farmers' income was increased and they were able to save money and thereby donate more money than the past through raising their participation in mango production practices.

The shape of the pentagon (Figure 2) displayed schematically the variation in farmer's access to assets. It shows the change of livelihood status of BARI Aam-3 farmers. Medium farmers were able to change all types of capital moderately than the small farmer. It is evident from the figure that livelihood status of large farmers has changed tremendously through BARI Aam-3 mango cultivation.

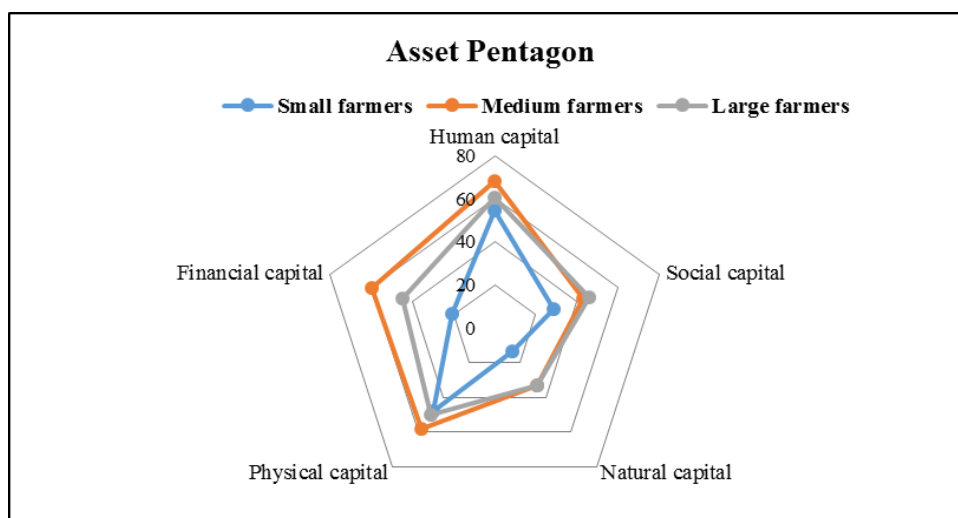


Fig. 2. Livelihood status of sample mango farm households

Table 10 shows that the significant improvement took place in farmer's livelihood due to the production of BARI Aam-3 variety in the study areas. Due

to the adoption of BARI Aam-3 variety, small farmers were able to improve their human and physical capital by 54.34% and 48.17% respectively. In the case of medium farmer's, human, financial and physical capital was increased by 68%, 60% and 58% respectively. But the adoption of BARI Aam-3 mango variety changed human capital and physical capital by 60.5% and 50% respectively for large farmer.

Table 10. Distribution of livelihood capital of BARI Aam-3 mango orchard owner

Asset category	Improvement of livelihoods (%)		
	Small farmers	Medium farmers	Large farmers
Human capital	54.34	68.00	60.54
Social capital	28.50	43.30	45.95
Natural capital	13.65	33.30	33.33
Physical capital	48.17	58.00	50.00
Financial capital	20.47	60.00	44.60

Source: Field Survey, 2018

Conclusion and Recommendation

Cultivation of BARI Aam-3 mango is profitable because it gives substantial higher gross return and net return. Human labor, cost of saplings, insecticides were the major cost items for mango production in the study areas. The rate of returns (i.e. BCR, NPV and IRR) indicated that BARI Aam-3 cultivation is profitable for the farmers. After adopting this variety all types of farmer are able to change their livelihood. They are able to increase their human, physical and social capital significantly. It signifies that, BARI Aam-3 mango production has a good potentiality in Bangladesh. So, to sustain the yield of BARI Aam-3, the combined efforts of concerned authorities are essential at the level of policy formulation. Besides, a proper initiative should be taken to record the information on cost and return and to disseminate this information throughout the country.

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Appendix
Table 1. Changes in livelihood status of BARI Aam-3 mango orchard owner

Livelihood Assets	Degree of change (Small orchard)			Degree of change (Medium orchard)			Degree of change (Large orchard)		
	Increased	Decreased	Constant	Increased	Decreased	Constant	Increased	Decreased	Constant
Human Capital									
Health & Sanitation	36.4	-	63.6	100	-	-	70.27	-	29.73
Education	72.7	-	27.3	80	-	20	72.97	-	27.03
Training	81.8	-	18.2	20	-	80	16.22	-	83.78
Knowledge	18.2	-	81.8	60	-	40	64.86	-	35.14
Nutrition	63.6	-	36.4	80	-	20	78.38	-	21.62
Average	54.34	-	45.46	68	-	32	60.54	-	39.46
Social capital									
Association	18.2	18.2	63.6	40	-	60	48.65	-	51.35
Politics	18.2	-	81.8	-	-	100	8.11	-	91.89
Management	27.3	-	72.7	40	-	60	35.14	21.62	43.24
Social Respect	54.5	18.2	27.3	80	20	-	70.27	13.51	16.22
Decision making	36.4	-	63.6	60	-	40	59.46	2.70	37.84
Women empowerment	18.2	-	81.8	40	-	60	54.05	-	45.95
Average	28.8	6.06	65.13	43.3	3.3	53.3	45.95	6.31	47.75
Natural capital									
Own cultivable land	27.3	-	72.7	20	-	80	43.24	-	56.76
Lease cultivable land	-	45.5	54.5	40	-	60	40.54	-	59.46

Pond	-	45.5	54.5	-	20	80	10.81	24.32	64.86
Water use	36.4	-	63.6	40	-	60	40.54	-	59.46
Safe drinking water	18.2	-	81.8	80	-	20	56.76	-	43.24
Forestry	-	63.6	36.4	20	20	60	8.11	40.54	51.35
Average	13.65	25.76	60.58	33.3	6.7	60	33.33	10.81	55.86
Physical capital									
Brick built house	72.7	-	27.3	60	-	40	54.05	-	45.95
Furniture	36.4	-	63.6	80	-	20	75.68	-	24.32
Ag. Tools	9.1	18.2	72.7	60	40	-	51.35	8.11	43.24
Vehicle	9	-	91	40	20	40	37.84	-	62.16
Tube well	91	-	9	20	-	80	8.11	24.32	67.57
Electricity	54.5	-	45.5	80	-	20	51.35	-	48.65
TV/radio/cable network	63.6	-	36.4	60	-	40	40.54	-	59.46
Mobile phone	81.8	-	18.2	100	-	-	89.19	-	10.81
Toilet	63.6	-	36.4	40	-	60	59.46	-	40.54
Livestock	-	81.8	18.2	40	40	20	32.43	24.32	43.24
Average	48.17	10	41.83	58	10	32	50.00	5.68	44.59
Financial capital									
Cash in hand	36.4	-	63.6	100	-	-	78.38	-	21.62
Bank/Savings	18.2	-	81.8	40	-	60	21.62	40.54	37.84
Jewels	-	18.2	81.8	40	-	60	8.11	37.84	54.05
Donation/grant/aid	27.3	-	72.7	60	-	40	70.27	18.92	10.81
Average	20.47	4.55	74.97	60	-	40	44.60	24.33	31.08

(-) indicates no change.