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RESEARCH ARTICLE

Socioeconomic Impact of Foot and Mouth Disease Vaccination in Pakistan

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ABSTRACT

Socioeconomic impact of Foot and Mouth Disease (FMD) vaccination through the project 'Progressive control of FMD in Pakistan' during 2013 to 2015 on rural and peri-urban farmers was assessed in this study. It was based on cross sectional data of 666 farmers; including 347 project participating, 209 non-participating and 110 control group farmers. The disease incidence declined from baseline level of 40% during year 2009-12 to 18% during year 2012-15 at sample farms. Similarly, frequency of the disease occurrence also decreased considerably over the time period. Thus, Vaccination of the animals is found to be effective in preventing clinical disease. Moreover, vaccination program created awareness among peri-urban farmers in general and rural farmers in particular and helped change their approach to tackle the disease. Due to better recovery of sick animals; abortion cases, effects on milk quality, treatment cost and replacement ratios of milking animals are found lower at the project participating farms than non-participating and control group farms. Financial losses due to the disease are observed the lowest at the farms of project participating farms in rural areas for both cows & buffaloes, and for buffaloes in peri-urban areas as well. Decrease in milk production, distress sales of animals, weight loss, feeding improvements and other losses share, about 81, 8, 5, 4 and 2 percent, respectively in total financial loss due to the disease. In the scenarios of with and without vaccination, benefit cost ratios (BCRs) of animals' vaccination are found to be 19.5 and 13.4 for buffaloes and cows in rural areas, respectively. Similarly, BCRs of the vaccination of buffaloes and cows in peri-urban areas are 3.1 and 4.8, respectively.

INTRODUCTION

The livestock sub-sector of agriculture has emerged as a priority sector on policy formulation and occupies a unique position in the national agenda of economic development in Pakistan. In the financial year 2017-18, livestock sub-sector contributed 11.11 percent to the national GDP, and shared 58.92 percent to agricultural value added. In the country, nearly 8.0 million rural families are involved in raising livestock. The livestock production is considered as an important segment of daily life and is main source of highly nutritive foods like milk, meat, eggs and cheese. The sub-sector also provides different byproducts in the form of leather, hides and farm yard manure. Productivity of livestock in the country is generally low due to poor supply of feed and fodder, inadequate husbandry practices and livestock disease problems (Anonymous, 2018).

FMD is a major infectious disease of cloven footed livestock, endemic in nature and frequent outbreaks occur throughout the country (Qurban, 2012, Abubakar et al., 2012; 2015; 2017). Frequent occurrence of the disease is one of the main reasons of low productivity of livestock in the country (PARC, 2014; Ahmed et al., 2017). Poor veterinary infrastructure, absence of proper diagnosis of FMD, unawareness among the farmers about recognizing clinical signs of the disease and high cost of vaccines are reasons of endemic situation of the disease (Kivaria, 2003). FMD causes distress to animals and effects livelihood of the farmers. The people who are directly dependent on livestock for their living have

to face big impact in the form of malnutrition. The disease causes heavy economic losses to the sub sector in terms of high morbidity in adult animals and mortality in young stock. The economic losses are mainly due to decrease in milk production, weight loss, loss of work efficiency in draught animals and changes in herd structure (Venkataramanan et al., 2006). This also results into increase in expenditures on feed, medication and shelter. Farm families are affected emotionally and suffer stress, strain and distress. Beyond farm the disease also cost retailers and consumers higher prices due to shortage of livestock products.

The disease can be tackled in two ways; eradication by stumping out and control through vaccination on regular basis as well as in the face of outbreak. Though, eradication is the lowest cost policy; however, when it is not feasible, it is economically beneficial to protect high producing livestock by vaccination. Most of the countries having endemic nature of FMD follow high costing vaccination strategy (James and Rushton, 2002), which is also supported by application of zoo-sanitary measurers and restriction on the movement of infected animals (Jamal et al., 2010). Though there is a huge number of FMD affected animals in the disease endemic countries, the impact of the disease has received less attention in these countries than the impact of outbreak in the disease-free countries. The cattle are more susceptible to the disease in the world as well as in Asia. In the year 2008, 4.37% of cattle population and just 0.38% of buffalo population suffered from the disease (Knight-Jones and Rushton, 2013; Abubakar et al., 2017).

FMD is a trans-boundary animal disease and has major economic implications through the cost of the measures taken at individual, collective and international levels in order to prevent or control infection and disease outbreaks. Thus, effective control of FMD will result into financial as well as social benefits to the farmers, consumers and nations (Otte et al., 2004). An initiative was taken by FAO national project under GCP/PAK/123/USA with a hope to provide framework for progressive control of FMD in Pakistan. Under this initiative, regular vaccination of FMD was carried out in specified areas/regions throughout the country. Current study was undertaken to assess socioeconomic impact of FMD vaccination in Pakistan, with specific objectives of ascertainment of knowledge of the farmers about the diagnosis, vaccination and treatment of FMD, and to assess economic gains due to the disease control to project participating farmers.

MATERIALS AND METHODS

Study area

Study area was whole country, as 'Progressive control of FMD in Pakistan' project has been implemented throughout the country, including all provinces, Azad Jammu and Kashmir (AJK), Federally Administrated Tribal areas (FATA), Gilgit-Baltistan (GB) and Islamabad Capital Territory (ICT).

FMD vaccination

The Project deviced vaccine (having most appropriate vaccinal serotypes for local FMD isolates) that was transported through cold chain and administrated in animals of more than three months of age sub-cutanously at the dose of 2ml per animal. Animals were vaccinated in two shots i.e. primary and booster doses at same dose rates with a time period of four weeks. Then the procedure was repeated after every six months.

Study design

A baseline survey was conducted in 2013 in all the regions of the country except Gilgit-Baltistan. A comprehensive formal survey of the target farmers was conducted through a well-developed pre-tested questionnaire. As the 'Before' and 'After' as well as 'With' and 'Without' comparisons are crucial for impact analysis, thus both type of farms; FMD vaccinated through project and non-vaccinated were surveyed. In addition, to the project control few farmers from areas where project was not executed were also surveyed.

Impact assessment survey was conducted during November and December, 2015. In peri- urban areas impact assessment survey was conducted in five dairy colonies, two in Karachi and one each in Lahore, Peshawar and Quetta. In rural areas, farmers from three districts of Punjab, Sindh and AJK each; and two districts each of Khyber Pakhtunkhwa, Balochistan and FATA were interviewed. As the Gilgit-Baltistan region was not surveyed in the base line, thus was also not surveyed for impact assessment study. Region and dairy production system wise details of area surveyed for impact assessment of the project are given in Table 1.

Sample size and survey

Sample size for the impact assessment survey was 666 dairy farmers (including 347 project participating, 209 non-participating and 110 control group farmers) in all the regions. Details of sample farms surveyed for the study by farming types (i.e. rural livestock and peri-urban/dairy colony farms), by farming category (project participating/vaccinated, project non-participating/non-vaccinated, and control farms i.e. from non-project area) across different provinces/ regions are given in Table 2. Out of the sample farms in both farming types, more than half were project participating farms. Out of rural livestock farms, 275 were project vaccinated (52%), 154 were project non-vaccinated (29%), and 102 were control group farms (19%). In peri-urban farms, 72 were project vaccinated (53%), 55 were project non-vaccinated (41%), and 8 were control group farms (6%).

Table 1: Study area by farming systems (Names of Districts)

Dairy Production System	Regions					
	Punjab	Sindh	Khyber Pakhtunkhwa	Balochistan	AJK	FATA
Rural Livestock Farms	1. Jhang 2. Attock 3. R. Y. Khan	1. Thatta 2. Tando Allahyar 3.Nowshero Feroze	1. Nowshera 2. Abbottabad	1. Pishin 2. Lasbella	1. Mirpur 2. Muzaffarabad 3. Poonch	1. Mohmand Agency 2. Bajaur Agency
Peri- Urban/ Dairy Colony	1. Lahore	1. Laundi Karachi 2. Negori Karachi	1. Peshawar	1. Queta	-	-

Table 2: Distribution of sample rural farms and dairy units by project intervention across provinces

Regions	Farm Category			
	Participating	Non-participating	Control	Total
Rural Livestock Farms (No.)				
Punjab	62 (52)	36 (30)	21 (18)	119 (100)
Sindh	62 (50)	39 (32)	22 (18)	123 (100)
KP	35 (46)	22 (29)	19 (25)	76 (100)
Balochistan	37 (47)	31 (39)	11 (14)	79 (100)
AJK	36(49)	19 (26)	19 (26)	74 (100)
FATA	43 (72)	7 (12)	10 (17)	60 (100)
Total	275 (52)	154 (29)	102 (19)	531 (100)
Peri Urban/ Dairy Colony				
Punjab	16 (49)	11 (33)	06 (18)	33 (100)
Sindh	17 (53)	14 (44)	01 (3)	32 (100)
KP	23 (70)	09 (27)	01 (3)	33 (100)
Balochistan	16 (47)	21 (57)	0 (0)	37 (100)
AJK	0 (0)	0 (0)	0 (0)	0 (0)
FATA	0 (0)	0 (0)	0 (0)	0 (0)
Total	72 (53)	55 (41)	08 (6)	135 (100)

Note: Figures in parenthesis are percentages.

Table 3: Farmers keeping cattle and buffaloes by farming types and regions, & by project intervention (Number of Farmers)

Farming Types	Animal Types	Farm Category			
		Participating	Non-participating	Control	Total
I. Farmers reported to keep cows and buffaloes by project intervention					
Rural Livestock Farming	Buffalo	176 (64)	98 (67)	70 (69)	344 (65)
	Cow	216 (79)	128 (83)	85 (83)	429 (81)
Peri Urban/ Dairy Colony	Buffalo	70 (97)	53 (96)	07 (88)	130 (96)
	Cow	66 (92)	49 (89)	8 (100)	123 (91)
II. Farmers keeping cows and buffaloes alone and in mixed farms by project intervention					
Rural Livestock Farming	Buffalo Alone	58 (21)	26 (17)	17 (17)	101 (19)
	Cattle Alone	97 (35)	56 (36)	32 (31)	185 (35)
	Mixed farms	120 (44)	72 (47)	53 (52)	245 (46)
Peri Urban/Dairy Colony	Buffalo Alone	06 (8)	06 (11)	0 (0)	12 (9)
	Cattle Alone	02 (3)	02 (4)	01 (13)	05 (4)
	Mixed farms	64 (89)	47 (86)	07 (88)	118 (87)

Note: Figures in parenthesis are percentages. Project intervention means where project carried out vaccination.

To determine the impact of project intervention by animal types, sample livestock farms are distributed into two categories i.e. cattle and buffalo farms by farm categories with respect to project intervention (Table 3, Part I). However, for better understanding of the readers distributions of sample farms by types of animal (cattle alone, buffalo alone, mixed farms) and by farm categories with respect to project intervention are also given in Part II of Table 3. Second distribution has been used for analysis of the data, particularly about disease incidence i.e. frequency of the disease occurrence since project intervention in year 2012-13, and occurrence of the disease by vaccination coverage.

Statistical and economic analysis

Chi-square statistics are used to determine whether there are significant difference between the expected frequencies and the observed frequencies of actions taken in case of suspicions about FMD outbreak & incidence, supervision during vaccination administration and awareness about cold chain maintenance across farming categories. Economic losses occurred due to the disease outbreak has been

computed across farming categories by farming types. Financial losses due to decrease in milk production, cost of improved feeding, treatment expenses on sick animals; losses due to animal weight decrease, cases of animal abortion, animals' death and draught/ traction power are added to compute total economic losses due to the disease on per farm basis.

RESULTS

Livestock profile

Population of buffaloes and cows at sample rural farms surveyed for impact assessment of the project was 2484 and 2776, respectively (Table 4). Thus, rural farms have almost equal proportion of animal types i.e. 47% and 53% of the animal population was comprised of buffaloes and cattle, respectively. Mean number of large ruminants at rural farms was 10 per farm, comprised of 5 buffalo and cattle each. Peri-urban dairy farms have high share of buffaloes in animal population. Buffalo and cattle population at these farms was 13992 (75%) and 4764 (25%), respectively. Mean number of large ruminants at peri-urban dairy farms was 139 per farm, including 103 buffaloes and 36 cattle.

Knowledge about the Disease Diagnosis, Vaccination and Treatment

In rural areas percentage of the farmers, who reported to call veterinary staff (VOs/VAs) for treatment of FMD affected animals is found the highest in project participating farmers (83%) among farming categories (Table 5, Part I). Actions taken by the farmers in case of suspicions about the disease outbreak in rural areas are statistically different across farming categories. While, in peri-urban areas, actions reported by the farmers were quite similar and also statistically insignificantly different across farming categories. Most of the rural livestock farmers (79%) as well as per-

Table 4: Animal Type wise inventory of dairy animals at sample farms by farming types and project intervention (Number of Animals)

Farming Types	Animal Types		Farming Category			
			Participating	Non-participating	Control	Total
Rural Livestock Farming	Buffaloes	In Milk & Dry	770 (3)	393 (3)	301 (3)	1464 (3)
		Others	555 (2)	248 (2)	217 (2)	1020 (2)
		Total	1325 (5)	641 (5)	518 (5)	2484 (5)
	Cattle	Cows in Milk & Dry	826 (3)	453 (3)	258 (3)	1537 (3)
		Others	670 (2)	369 (2)	200 (2)	1239 (2)
		Total	1496 (5)	822 (5)	458 (5)	2776 (5)
Peri Urban/ Dairy Colony	Buffaloes	In Milk & Dry	6652 (106)	5327 (97)	271 (34)	12250 (90)
		Others	822 (11)	830 (15)	90 (11)	1742 (13)
		Total	7474 (117)	6157 (112)	361 (45)	13992 (103)
	Cattle	Cows in Milk & Dry	1663 (24)	1275 (23)	61 (8)	2999 (22)
		Others	952 (14)	749 (13)	64 (8)	1765 (14)
		Total	2615 (38)	2024 (36)	125 (16)	4764 (36)

Note: Others include calves, heifers & bullocks, and figures in parenthesis are mean number of animals per farm.

Table 5: Actions taken in case of suspicions about FMD outbreak & incidence, supervision during vaccination administration and awareness about cold chain maintenance (Number of Farmers)

Farming Type	Actions Taken	Farming Category				$P \geq \chi^2$
		Participating	Non-participating	Control	Total	
I. Actions taken in case of suspicions about the disease outbreak						
Rural Livestock Farming	Call the VO/VA	227 (83)	95 (62)	73 (72)	395 (74)	
	Call the Quack	2 (1)	3 (2)	1 (1)	6 (1)	
	Call an Expert	6 (2)	14 (9)	6 (6)	26 (5)	0.005***
	Try to treat on their own	33 (12)	32 (21)	20 (19)	85 (16)	
	Do nothing	7 (2)	10 (6)	2 (2)	19 (4)	
Peri Urban/ Dairy Colony	Call the VO/VA	55 (76)	41 (74)	6 (74)	102 (76)	0.329 ns
	Call the Quack	2 (3)	1 (2)	0 (0)	3 (2)	
	Call an Expert	2 (3)	1 (2)	0 (0)	3 (2)	
	Try to Treat on Their own	13 (18)	10 (18)	1 (13)	24 (18)	
	Do nothing	0 (0)	2 (4)	1 (13)	3 (2)	
II. Supervision during vaccination administration						
Rural Livestock Farming		246 (90)	111 (71)	64 (63)	421 (79)	0.000***
Peri Urban/Dairy Colony		62 (86)	41 (75)	5 (63)	108 (80)	0.120ns
III. Cold chain maintenance awareness						
Rural Livestock Farming		192 (70)	79 (51)	48 (47)	319 (60)	0.000***
Peri Urban/ Dairy Colony		56 (78)	35 (64)	6 (75)	97 (72)	0.210 ns

Note: *** is significant at 1 percent level, and ns stands for non-significant.

urban farmers (80%) reported to supervise FMD vaccination during its administration at their farms (Table 5, Part II). In both farming types, awareness about maintaining cold chain to keep the vaccine effective was higher in project participating farmers than their counterparts (Table 5, Part III). Differences across farming categories both in supervision during vaccination administration & awareness to keep cold chain maintenance to keep vaccine effective were statistically different in rural areas, while opposite was the case in peri-urban setting.

Similarly, higher number of project participating farmers reported to isolate the diseased animals from healthy ones both in rural (64%) and peri-urban areas (48%) as compared to project non-participating (47% & 35% in rural and peri-urban areas, respectively) and control group farmers (57% & 42%, respectively). As a precautionary measure to control the disease, about one-third of project participating farmers (66%) and one-half each of project non-participating (52%) and control group farmers (50%) reported to vaccinate their animals. In rural livestock farming, 38 percent of the sample farmers and in peri-urban dairy colonies 88 percent of the sample farmers reported that FMD vaccine was available to them in local markets. In rural areas, livestock department and in peri-urban areas veterinary stores were reported as main sources to avail the vaccines by the farmers.

FMD incidence and prevalence

Eighteen percent of the farmers (120 out of 666) reported the disease outbreak at their farms during year 2012 to 2015. The disease outbreak at farms having cattle alone was high in rural than peri-urban areas, while opposite were the cases for buffalo alone and mixed farms (Table 6). In peri-urban areas occurrence of the disease at mixed type of farms of project participating farmers was lower than their counterparts. Similarly, it was lower at cattle and buffalo farms of project participants than that of non-participants. Similar to positive role of the project activities on disease incidence, frequency of occurrence of FMD also reduced over time at project participating farms.

In rural setting disease prevalence in buffaloes and cows both at project participating farms was lower than other farm categories. On an average disease prevailed for 11 and 15 days in buffaloes and cows at the farms of project participants, respectively. Project intervention resulted into better social orientation of the project participating farmers. Effective vaccination through the project and their social openness resulted in early recovery of sick animals.

Milk production and financial losses

FMD affects lactation length of milking animals. Mean decrease in lactation length due to the disease was about one and a half month in cows (47 & 49 days in peri-urban and rural areas, respectively) and two months in buffaloes (55 days in peri-urban and 57 days in rural areas). Out of the FMD outbreak reporting farmers, about one-half of buffalo farmers (47%) in rural areas and one-fourth (26%) in peri-urban areas reported disturbance in calving interval of their animals. Mean number of cases per farm were one buffalo in rural areas and two buffaloes in peri-urban areas, with additional period in inter-calving of about three months in both farming types. In case of cows, 41% and 40% of the sample farmers reported disturbance in calving interval of their animals in rural and urban areas, respectively. Mean number of cases per farm of cows with disturbance in calving interval was one each in both rural and peri-urban areas, with additional period in inter-calving of 3.4 and 2.7 months, respectively.

Milk loss due to decrease in animal productivity of the diseased animals and resulting financial losses are presented in Table 7. Decrease in the milk production and resulting financial losses were low both in case of buffaloes and cows at project participating farms than other farm categories. Similarly, in peri-urban setting, decline in milk production and resulting financial losses at the farms of project participants were low in case of buffaloes. However, decline in milk production and financial losses were high in case of cows. Moreover, variability of standard deviation around the mean milk production was low at the farms of project participating farms in case of cows in both farming types and in buffaloes in rural areas.

Table 6: Occurrence of FMD at sample farms during 2012-15 (Number of Farms)

Farming Type	Farm Type	Farming Category			
		Participating	Non-participating	Control	Total
Rural	Buffalo alone	4 (7)	2 (7)	5 (29)	11 (11)
Livestock	Cattle alone	4 (4)	22 (39)	8 (25)	34 (32)
Farming	Mixed farms	5 (4)	14 (19)	16 (30)	35 (14)
	Total	13 (5)	38 (25)	29 (28)	80 (15)
Peri Urban/	Buffalo alone	1 (17)	3 (50)	0 (0)	4 (33)
Dairy Colony	Cattle alone	0 (0)	1 (50)	0 (0)	1 (20)
	Mixed farms	8 (13)	26 (55)	1 (14)	35 (30)
	Total	9 (13)	30 (54)	1 (13)	40 (30)

Note: Figures in parenthesis are percentages of farms.

Table 7: Milk production and financial losses due to FMD (Liter per Lactation)

Farming Types	Basis/Levels	Farming Categories			
		Participating	Non-participating	Control	Total
Rural	Per buffalo	403 (74.7)	611 (69.3)	795 (48.6)	671 (59.9)
Livestock	Per buffalo farm	491 (87.8)	1624 (187.9)	1771 (90.1)	1487(124.2)
Farming	Financial loss per buffalo farm (Rs.)	35177 (84.9)	120121 (165.1)	123108 (86.5)	105665 (124.0)
	Per cow	238 (100.0)	273 (136.3)	398 (67.8)	307 (107.5)
	Per cow farm	323 (78.6)	644 (171.1)	869 (110.6)	676 (68.0)
	Financial loss per cow farm (Rs.)	23385 (79.5)	46996 (172.6)	57747 (109.9)	47491 (149.0)
Peri Urban/	Per buffalo	825 (19.2)	837 (46.7)	535 (0.0)	820 (40.0)
Dairy	Per buffalo farm	3527 (96.8)	3656 (71.9)	5355 (0.0)	3692 (75.4)
Colony	Financial loss per buffalo farm (Rs.)	255817 (92.1)	271793 (74.7)	412335 (0.0)	273101 (75.4)
	Per cow	1351 (22.3)	992 (57.3)	-	1066 (50.7)
	Per cow farm	3378 (48.1)	3178 (63.8)	-	3221(59.6)
	Financial loss per cow farm (Rs.)	254137 (49.9)	233786 (63.8)	-	238146 (59.9)

Note: Figures in parenthesis are coefficients of variation.

As already mentioned that disease incidence was low at project participating farms. Similarly, abortion cases in animals were also low at the farms of project participating farms as compared to other farm categories. Only one project participating farmer (11% of the disease reporting farmers) reported abortion case in a buffalo. Farmers' responses regarding differences in quality of milk due to occurrence of FMD have also been recorded. Changes in quality of milk of both buffaloes and cows were reported low at project participating farms in rural areas, and in milk of cows in peri-urban settings. In rural areas low fat contents, change in odour and taste; and in peri-urban areas, changes in taste and colour were reported main effects of the disease on milk of FMD affected milking animals.

Medical treatment and feeding improvement costs

The treatment cost was considerably low at the farms of project participating farmers in case of cows in both rural and peri-urban areas, and in case of buffaloes in rural areas. The main reason was low incidence of the disease at these farms due to project intervention. However, in case of peri-urban buffalo farms the cost was high as compared to non-participating farms, still it was low than control group farms. Most of the sample farmers reported to improve feeding of the diseased animals along with providing them with medical treatment for quick recovery. Duration of improvement in feeding was comparatively longer in rural areas (3-4 weeks) than peri-urban areas (one week). Expenditures on improved feeding were higher at project participating farms in case of cows in rural areas, and buffaloes in peri-urban areas than other categories of farms.

Weight loss, death cases and losses in draught/ traction power

Financial losses due to animal weight loss were lower at project participating farms than control group farms for both buffaloes and cows in rural areas and for buffaloes in peri-urban areas. In rural areas none of the project participating farmers reported death cases in buffaloes and cows. However, in peri-urban areas, two project participating farmers (22% of disease reporting farmers) reported death of buffaloes and one farmer (13%) reported death of one cow. In rural farming system, few of the disease reporting sample project participating farmers (3 out of 9, 33%), and non-participating farmers (2 out of 36 or 13%) reported to use cattle bulls, and buffalo bulls (2 out of 16 or 6%) for drought and traction purposes. Out of these one of the project participating and all non-participating farmers reported loss in draught/ traction power at their farms.

Animal sales, replacement ratios and distribution of financial losses by types

Sales of milking animals due to decrease in productivity were higher in rural areas (2.9% and 3.2% of milking buffalo and cow population, respectively) than peri-urban areas (0.4% and 0.5% of milking buffalo and cow population, respectively). Fewer project participating farmers reported distress animal sales; moreover, cases of distress sales by these farmers were also lower than farmer of other categories. During 2012-15, replacement ratios of animals were 4.7, 8.1 and 10.4 at rural livestock farms and 5.9, 17.0 and 10.1 at peri-urban dairy farms on project participating, non-participating and control group farms, respectively. Farmers replaced mainly milking animals, as their replacement ratios were 4.0, 7.2 and 10.3 in rural areas, and 5.2, 16.9 and 10.0 in peri- urban areas on project participating, non-participating and control group farms, respectively.

Low replacement ratios at project participating farmers were due to low incidence of the disease, its shorter prevalence, comparatively stable milk production, and low cases of animal death. Financial losses by types are presented in Figure 1. Decrease in milk production is the main loss due to the disease and shares 81 percent in total financial losses, followed by distress sales of animals, weight loss, feeding improvement and other losses (treatment cost, abortion cases, animal death and loss in draught/traction power).

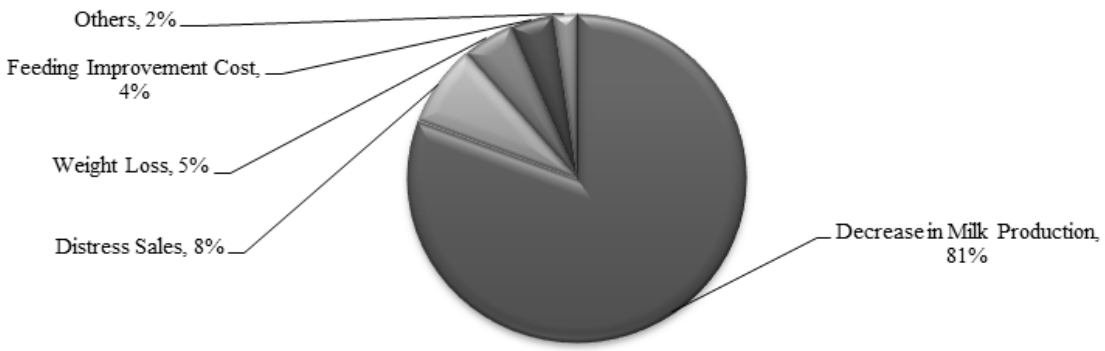

Fig. 1: Types of financial losses.

Table 8: Comparison of financial losses and economic gains per annum

Farming Type	Ani-mal Type	Types of Loss	Farming Category		
			Participating	Non-participating	Control
Rural Live-stock Farming	Buffalo	A. FMD Reporting Farms (No.)	9 out of 176 (5)	16 out of 98 (16)	21 out of 70 (30)
		B. Losses per FMD Reporting Farm (Rs.)	53492	173615	153557
		C. Losses per Sample Farm (Rs.)	2735	28345	46067
		D. Animal Population at Sample Farms (No.)	1325	641	518
		E. Loss per Animal at Sample Farms (Rs.)	363	4334	6225
		F. Economic Gains & BCR	Rs. 5862 per animal & 19.5		
	Cow	A. FMD Reporting Farms (No.)	9 out of 216 (4)	36 out of 128 (28)	24 out of 85 (28)
		B. Losses per FMD Reporting Farm (Rs.)	59572	106402	83736
		C. Losses per Sample Farm (Rs.)	2482	29926	23643
		D. Animal Population at Sample Farms (No.)	1496	882	458
		E. Loss per Animal at Sample Farms (Rs.)	358	4343	4388
		F. Economic Gains & BCR	Rs. 4030 & 13.4		
Peri Urban/ Dairy Colony	Buffalo	A. FMD Reporting Farms (No.)	9 out of 70 (13)	29 out of 53 (55)	1 out of 7 (14)
		B. Losses per FMD Reporting Farm (Rs.)	320939	246137	474235
		C. Losses per Sample Farm (Rs.)	41264	134679	67748
		D. Animal Population at Sample Farms (No.)	7474	6157	361
		E. Loss per Animal at Sample Farms (Rs.)	386	1159	1314
		F. Economic Gains & BCR	928 & 3.1		
	Cow	A. FMD Reporting Farms (No.)	18 out of 66 (27)	27 out of 49 (55)	0 out of 8 (0)
		B. Losses per FMD Reporting Farm (Rs.)	271683	246989	0
		C. Losses per Sample Farm (Rs.)	74095	136096	0
		D. Animal Population at Sample Farms (No.)	2615	2024	125
		E. Loss per Animal at Sample Farms (Rs.)	1870	3295	0
		F. Economic Gains & BCR	1425 & 4.8*		

Note: Figures in parenthesis are percentages, E= C x Sample Farms (#) / D. * By considering project participating farms instead of control group farms.

Comparison of financial losses and economic gains by project intervention

Vaccination of animals was much effective in controlling the disease in the study area. The lowest percentages of the project participating farmers reported disease incidence/outbreak at their farms (Table 8). Similarly, financial losses due to FMD at these farms were lower than other farming categories. Comparison of losses at project participating farms with control group farms categories showed that annual economic gains per animal with FMD vaccination at project participating farms are Rs.5862 & Rs.4030 in rural livestock farming, and Rs. 928 & Rs.1425 in peri-urban settings, for buffaloes and cows, respectively. Benefit cost ratios (BCRs) of vaccination of animals against FMD are found to be 19.5 and 13.4 for buffaloes and cows in rural areas, respectively. Similarly, BCRs of the vaccination of buffaloes and cows in peri-urban areas are 3.1 and 4.8, respectively. Thus, it is concluded that project intervention have a positive economic contribution and impact towards livestock farming in the country.

In addition to direct socioeconomic benefits to project participating farmers due to animal vaccination, 74% and 71% of them reported decrease in the disease incidence at their neighbouring livestock farms in rural and peri-urban areas, respectively. Similarly, considerable number of project participating rural (30%) and peri-urban farmers (49%) reported increase in livestock inventory and employment generation (6%

`and 10% in rural and peri-urban areas, respectively) due to positive economic impact of the disease control at their farms. Besides economic benefits, availability of quality vaccination and better control of the dieses were reported as reason to increase livestock inventory at project participating farms. Project activities created awareness among farming communities about the disease control and thus resulted in decreases in incidence and chances of its outbreak. Better disease control, improvement in profitability through quality vaccination and control over financial losses etc. are reported by project participating farmers as main advantages of the vaccination of animals through the project.

DISCUSSION

FMD is a major infectious disease of cloven footed livestock in Pakistan, which is endemic in nature with frequent outbreaks (Qurban, 2012; Abubakar et al., 2015). The disease results into low livestock productivity and socioeconomic losses to the farmers in the country. Venkataramanan et al., 2006 reported that financial losses to the farmers occur mainly due to decrease in milk production, weight loss and changes in herd structure. Results of the present study are in line with their findings. Decrease in milk production is the main loss and shares about four-fifth in total losses. Distress sales of animals, weight loss, feeding improvement and other losses (including treatment cost, abortions, animal death & loss in drought/traction power) share in remaining one-fifth of the losses in decreasing order.

Most of the countries having endemic nature of FMD follow high costing vaccination strategy (James and Rushton, 2002; Abubakar et al., 2017). Pakistan follows the same strategy, under which FAO-FMD control project was executed. Regular interaction of the project staff with farmers has increased awareness among them about recognition of the disease symptoms. Similarly, project intervention contributed positively in controlling FMD in the country. Shah et al. (2014) in baseline study conducted for the project reported occurrence of FMD at 40% of sample farms in Pakistan during 2009-12. While, in the impact assessment survey conducted for the study only 18% of the farmers reported the disease outbreak at their farms during 2012-15. Thus, incidence of disease decreased more than one-half level through effective vaccination services provided to the farmers through the project.

Cattle are more susceptible to the disease than buffaloes in rural areas of the country. The findings are in line with that of Knight-Jones and Rushton, 2013 and Abubakar et al., 2017. In peri-urban areas, disease prevailed in buffaloes for 15 days at the farms of project participants, mean disease duration at these farms was equal to that on non-participant farms, but higher than at control group farms (7 days). In case of cows, disease prevalence period across farm categories was same, and on an average disease prevailed for 12 days. Ferrari et al. (2013) in their study about the effect of FMD on milk yield in Pakistan reported significant decrease in yield in two months following the onset of the disease. However, to appropriately determine decrease in milk production due to the disease, milk losses have been estimated at two stages; during the disease period and after recovery from the disease. Decrease in milk production has been considered for the entire period of the remaining lactation in cases, where milk production does not return to normal level.

Coefficients of variation are calculated for milk losses on animal and farm level basis and for resulting financial losses. Animal replacement ratios (number of animals purchased, divided by number of animals sold) by farming categories during project period (2012-15) have also been determined. These were lower at project participating farms than other farm categories due to better disease control through vaccination as per expectation. Benefit Cost Ratios (BCRs) of FMD vaccination are determined by animal and farming types. BCRs are determined by considering reduction in financial losses by vaccinating animals at project participating farms against losses occurred at control group farms as economic gains and considering vaccination cost Rs. 300 per animal per year.

Project participating farmers gained considerably in economic terms through animal vaccination throughout the country. Economic gains to the farmers were higher in rural farming system than in peri-urban dairy colonies. The obvious reason was high susceptibility of animals to the disease in far-flung rural areas due to lack of vaccination and treatment facilities than in peri-urban commercial farming system. Thus, control of high losses due to FMD results into higher gains to the farmers in rural livestock farming.

Conclusion

The project has positive impact on livestock farming in the country through better treatment of the diseased animals. Project activities have created awareness among farming communities about FMD control. Due to this, incidence of diseases and chances of its outbreak have decreased. Effective vaccination of the animals has resulted into increase in profitability of livestock farmers. Gains in livestock inventory and employment are also reported due to positive economic impact of the disease control at few projects participating farms. Though, the country has achieved higher status in FMD progressive control pathway (from ‘stage 1’ to ‘stage 2’). However, still a long way is to go to achieve higher stages of progressive control pathways, achieving stage 5 (maintain zero circulation

incursions; withdraw vaccination), and ultimately to achieve free without vaccination status.

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Authors' contributions

AH, MA, MH and MA planned the study. AH, HS, MJA and MA executed the study and performed sampling and survey. AH and MA analyzed and prepared the draft manuscript. All authors have read and endorsed the final manuscript.

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