Chapter 5
Livestock Manure Market and Agricultural Sustainability

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7.1. Introduction

One of the most serious problems of Turkish agriculture is a long run decrease in soil fertility. This is caused by strongly intensive use of land and decrease of area where fallow technology had been operated. Since 1960s, irrigation has been introduced gradually, and introduction of new type chemical fertilizer/seed has been done since 1980s. These progresses raised productivity of agriculture, but caused problem mentioned above. There are three types of fertilizer; chemical fertilizer, leguminous crops, and manure/compost. Chemical fertilizer is very useful material for relatively short-term fertilizing function, but act directly on crops. And so does not maintenance total balance of soil fertility. Leguminous crops have Nitrogen fixing function. Nitrogen is important element for plant to grow. But of course plant needs not only Nitrogen but also Phosphorus, Potassium, and many other elements. Leguminous crops also cannot supplement all. Additionally, these two types cannot refill amount of soil. By contrast, manure/compost includes many elements to supplement and can refill amount of soil. For long-term soil fertility, manure/compost is the ideal fertilizer. Furthermore, the greater part of Turkey except for some riverside and seaside areas are arid areas, and so there are not many trees in Turkey. Then, manure made from livestock becomes most important for sustainable agriculture in Turkey. In order to improve soil fertility, input of livestock manure into land is required. In other words, crop farming system and livestock production should be integrated effectively. Is there enough volume of manure that can support sustainable farming in Turkey?

First, we will check the number of livestock and situation of animal husbandry briefly, because number of animals is strongly related to possibilities of manure input. Second, supply and demand for livestock manure will be checked from the viewpoint of economics. Third, we will discuss what are the factors that make farmers input livestock manure to land they manage. Finally, some conclusions and scenario of my research will be shown.

In this report, the data that were collected in our second village survey are used. This survey forms part of 'the Research Project on the Impact of Climate Change on Agricultural Production System in Arid Areas (ICCAP)'. The second survey was conducted in Adana City and Konya City of Turkey[1] from October to November 2003. Surveyed villages and number of household (H/H henceforth) in each village are as follows.

-1- Kayışlı (Adana, Irrigated village: IR henceforth, 25H/H are surveyed)

-2- Abdioğlu (Adana, IR, 24H/H are surveyed)

-3- Kılıçlı (Adana, Rainfed village: RF henceforth, 25H/H are surveyed)

-4- Belören (Adana, RF, 26H/H are surveyed)

-5- Alemdar (Konya, IR, 25H/H are surveyed)

-6- Beylerce (Konya, IR, 16H/H are surveyed)

-7- Çeşmelisebil (Konya, RF, 21H/H are surveyed)

-8- Karakaya (Konya, RF, 22H/H are surveyed)

1) Kusadokoro and Gulnur surveyed villages in Adana City and Kondo and Author surveyed villages in Konya City.

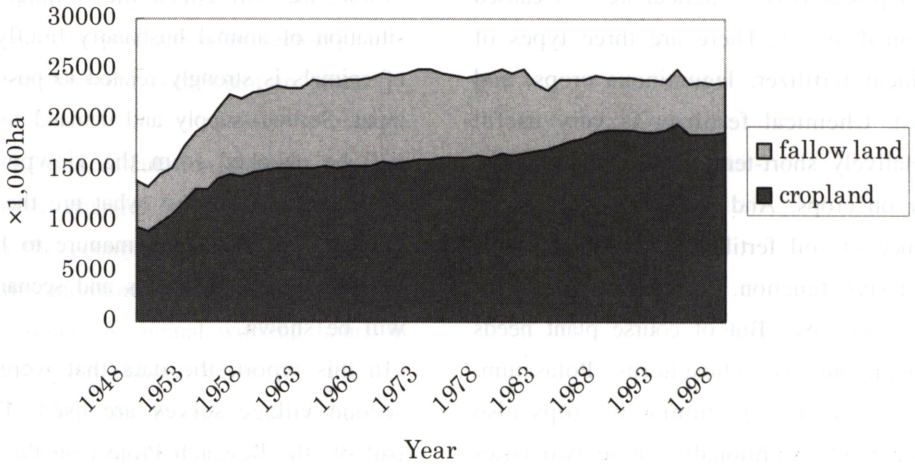
7.2. Animal Husbandry and Introduction of Irrigation

In this section, we will take a broad view of situation of animal husbandry in Turkey.

In Turkey, especially in Anatolian highland, extensive agriculture with animal grazing had been done. But these 20 years, total size of fallow land - that is important part of system of animal grazing - has decreased. Reasons for decreasing are as follows. Since 1960s, irrigation has been introduced and mechanization and introduction of chemical fertilizer/seed have been done. At first, irrigation has been introduced little by little. Secondly, introduction of chemical fertilizer/seed has been done actively in 1980s. The new type of seed that responds to chemical fertilizer better than old type was developed and introduced. The new type crops can grow even in area where used to need fallow to keep soil fertility if there are irrigated water and chemical fertilizer. As a result, total size of fallow land has decreased.

The below is Graph 1 and this graph shows changes in the size of cropland and fallow land. In fact, we can see the proportion of fallow land to total has been down from one-third to one-fifth.

Graph 1. Changes in the size of cropland and fallow land



Source: [9]

Furthermore, irrigation has affected number of livestock through the change of structure of crops. In irrigated area, farmers unanimously started to plant commercial crops that are more profitable than animal husbandry. Even in rain-fed area, there was a big impact on agriculture. Introduction of chemical fertilizer/seed led to farmers new varieties that react to chemical fertilizer very well. This feature impacts not only on decreasing size of fallow land but also on position of livestock manure farmers think. Because livestock manure is much heavier and so is more difficult to spread onto farmers' land than chemical fertilizer. This feature of livestock manure requires more equipment, facility and labor, and so makes the status of livestock manure down. As a result, the need for livestock manure has been decreased especially in rain-fed area[2].

Thus, number of livestock, especially sheep and goat[3], decreased particularly in irrigated area. Table 1 shows that changes in the number of livestock kept by surveyed farmers. According to this, number of livestock, especially number of sheep and goat in irrigated area, has decreased actually. Decreasing number of sheep and goat in rain-fed area from 1980 to 1990 seems to be an outcome of impact of introduction of chemical fertilizer/seed. From this table, it also become clear that number of sheep and goat in irrigated area was larger than that of rain-fed area and number of cattle in irrigated area is still larger than that

2) Of course, this impact goes for irrigated area, too. But in irrigated area, farmers plant commercial crops and these crops need basic soil fertility for growing up, so the need for livestock manure remains.
3) Contrary to cattle, sheep and goat need grazing.

of rain-fed area. Reasons are as follows. First, cattle are more suitable for intensive zero grazing than sheep and goat, and so more enterprising farmers in irrigated area tend to keep more cattle than farmers in rain-fed area. Second, animal grazing was and partially is prosperous in Konya region - located in Anatolian Highland - independently of irrigated area or rain-fed area. Generally, irrigated villages have larger land area than rain-fed villages in Konya region - because rain-fed villages stand on mountainous area, and so there were more pastureland and fallow land in irrigated area than in rain-fed area.

Table 1. Changes in the number of livestock kept by surveyed farmers

		Cattle			Sheep & Goat		
	Year	1980	1990	2003	1980	1990	2003
Rain-fed villages (94H/H)	No. of livestock	54	140	181	1782	1417	1878
	Ave.	3.00	5.00	5.17	77.48	59.04	78.25
	No. of keeping H/H	18	28	35	23	24	24
Irrigated villages (90H/H)	No. of livestock	443	434	366	2975	1982	463
	Ave.	13.42	12.40	9.63	185.94	152.46	115.75
	No. of keeping H/H	33	35	38	16	13	4
Total (184H/H)	No. of livestock	497	574	547	4757	3399	2341
	Ave.	9.75	9.11	7.49	121.97	91.86	83.61
	No. of keeping H/H	51	63	73	39	37	28

Note: `Ave.' means `No. of livestock per No. of keeping H/H'
Source: Survey data

7.3. Classification of Supply and Demand for Livestock Manure and Establishment of Livestock Manure Market

In the former section, it becomes clear that number of livestock, especially sheep and goat, has decreased in irrigated area. This decrease reduces supply of livestock manure. On the other hand, because of change of cropping pattern, the need for livestock manure has increased especially in irrigated area. In this section, we will check the disequilibrium of livestock manure by classifying the strata of supply and demand for livestock manure.

7.3.1. Intra-Household Disequilibrium of Livestock Manure

At first, farmers try to use livestock manure from their own yard. When farmers cannot manage to find enough volume of livestock manure from their own, they begin to get livestock manure from others. Now, we will check the balance that exists between supply and demand for livestock manure. Table 2 shows the most optimum volume of livestock manure input and possibilities of its supply. In this table, we use two values. These are calculated as follows.

(1) Desirable livestock manure input (DLMI): This is the best volume of livestock manure farmers think for land improvement. We got this data from our survey.

(2) Capable livestock manure input (CLMI): This is the volume farmers can afford to input onto their own land from livestock they keep. We suppose one cattle defecates 50kg excrement and urine, and one sheep (goat) defecates 10kg excrement and urine per day[4]. Through the drying process, 10kg excrement and urine is made to 6kg livestock manure.[5]

Firstly, we can find the fact number of household (H/H) CLMI exceeds DLMI is larger than number of H/H DLMI exceeds CLMI in rain-fed area, and number of H/H DLMI exceeds CLMI is larger than number of H/H CLMI exceeds DLMI in irrigated area. This fact can be thought as follows. In irrigated area, irrigation and introduction of chemical fertilizer/seed affected the choice of agricultural products and the decrease of pastureland and fallow land, and then

4) According to reference [5].
5) According to the interview of this time field survey to the extension service in Konya.

number of livestock decreased. And so, especially in irrigated area, supply and demand for livestock manure become out of balance. On the other hand, number of livestock in rain-fed area farmers keep is larger than those in irrigated area. In addition, cropping pattern in rain-fed area doesn't change so much. As a result, supply and demand for livestock manure is still in balance in rain-fed area.

Table 2. Comparison of DLMI and CLMI

		DLMI	CLMI	C≧D	C<D	C−D
Rain-fed villages (94H/H)	Total(ton)	17,023	6,095	5,020	-15,948	-10,928
	ton per da	0.533	1.129	1.767	-1.459	0.846
	No. of H/H	77	94	55	22	77
Irrigated villages (90H/H)	Total(ton)	19,596	5,022	1,912	-16,487	-14,575
	ton per da	2.218	0.488	0.972	-2.365	-1.531
	No. of H/H	64	90	16	48	64
Total (184H/H)	Total(ton)	36,619	11,116	6,932	-32,435	-25,503
	ton per da	1.298	0.816	1.588	-2.081	-0.233
	No. of H/H	141	184	71	70	141

Source: Survey data

7.3.2. Intra-Village and City Area Disequilibrium of Livestock Manure

When it comes to light that supply and demand for livestock manure is out of balance in household level, how about that in village level. Table 3 shows DLMI and CLMI per da in each village. Except Karakaya, this village stands on mountainous area and in winter most villagers move to Konya city, DLMI exceeds CLMI in irrigated area villages and CLMI exceeds DLMI in rain-fed area villages. This means that even in village level, supply and demand for livestock manure is out of balance in irrigated area.

Table 3. DLMI and CLMI per da in each village

	DLMI (ton/da)	CLMI (ton/da)
Kayışlı (IR, 25H/H)	1.10	0.83
Abdioğlu (IR, 24H/H)	0.48	0.06
Kılıçlı (RF, 25H/H)	0.20	0.70
Belören (RF, 26H/H)	0.23	1.00
Alemdar (IR, 25H/H)	2.12	0.68
Beylerce (IR, 16H/H)	5.00	0.81
Çeşmelisebil (RF, 21H/H)	0.10	0.85
Karakaya (RF, 24H/H)	4.23	0.39

Source: Survey data

7.3.3. Trade of Livestock Manure

Incidentally, when a farmer who doesn't have enough livestock manure to input into the land the farmer managed wants to do, what the farmer should do next. If there's other farmer nearby the farmer and who had a lot of livestock manure, they may have transactions. Table 4, Table 5 and Table 6 shows the result farmers purchased/sold from/to whom.[6] Table 4 shows the number of transaction. From Table 4, transactions in Adana are more frequent than those of Konya. Especially in Adana, tree crops, for example citrus, are planted in irrigated area and those need a lot of livestock manure continuously. But farmer who plants

6) These transactions are done in same city-areas.

tree crops regularly doesn't have enough amounts of livestock.[7] So farmers in this area want to have transactions more. On the other hand, long established cropping pattern is still going in Konya. Additionally, there is a custom that livestock manure is used as fuel in rural area of Konya. So farmers in Konya do not have transactions of livestock manure so frequently.

By the way, this table shows the existence of livestock manure traders. For example, farmers in Kılıçlı that stands near other irrigated village sold livestockmanure to traders well. Traders work as middlemen and trade not only livestock manure but also information about livestock manure. This existence of livestock manure traders is very important for the livestock manure market to grow up to next step. But in Konya, the existence of manure trader is not known well. Only a few farmers in Konya know that livestock manure is tradable.

Table 4. Purchase and sell of livestock manure: Number of trade

		From/to whom	Cattle		Sheep & Goat		Chicken		Total	
			Purchase	Sell	Purchase	Sell	Purchase	Sell	Purchase	Sell
Adana	Kayışlı (IR,25H/H)	Trader		2					0	2
		Friend		1					0	1
		Other		1					0	1
		Total	0	4	0	0	0	0	0	4
	Abdioğlu (IR,24H/H)	Trader							0	0
		Friend							0	0
		Other							0	0
		Total	0	0	0	0	0	0	0	0
	Kılıçlı (RF,25H/H)	Trader		8		1			0	9
		Friend							0	0
		Other							0	0
		Total	0	8	0	1	0	0	0	9
	Belören (RF,26H/H)	Trader							0	0
		Friend	3	3					3	3
		Other		4					0	4
		Total	3	7	0	0	0	0	3	7
	Subtotal (100H/H)	Trader	0	10	0	1	0	0	0	11
		Friend	3	4	0	0	0	0	3	4
		Other	0	5	0	0	0	0	0	5
		Total	3	19	0	1	0	0	3	20
Konya	Alemdar (IR,25H/H)	Trader					1		1	0
		Friend							0	0
		Other							0	0
		Total	0	0	0	0	1	0	1	0
	Beylerce (IR,16H/H)	Trader							0	0
		Friend							0	0
		Other							0	0
		Total	0	0	0	0	0	0	0	0
	Çeşmelisebil (RF,21H/H)	Trader							0	0
		Friend	1	0	1	1			2	1
		Other	1						1	0
		Total	2	0	1	1	0	0	3	1
	Karakaya (RF,22H/H)	Trader							0	0
		Friend							0	0
		Other							0	0
		Total	0	0	0	0	0	0	0	0
	Subtotal (84H/H)	Trader	0	0	0	0	1	0	1	0
		Friend	1	0	1	1	0	0	2	1
		Other	1	0	0	0	0	0	1	0
		Total	2	0	1	1	1	0	4	1
Total (184H/H)		Trader	0	10	0	1	1	0	1	11
		Friend	4	4	1	1	0	0	5	5
		Other	1	5	0	0	0	0	1	5
		Total	5	19	1	2	1	0	7	21

Source: Survey data

7) Because commercial crop is more profitable than animal husbandry and so cropping pattern in irrigated area, especially in Adana, has changed.

Table 5 shows how much amount of livestock manure is purchased/sold from/to whom. From this table, it can be said that farmers in Adana tend to trade more of livestock manure than those in Konya, similar to number of trade. Of course, there is a few numbers of trade in Konya, but it can be said that some farmers in Konya trade livestock manure as fuel and so traded (average) amount of livestock manure in Konya is smaller than that in Adana.

Table 5. Purchase and sell of livestock manure: Amount

(Unit: ton)

			Cattle		Sheep & Goat		Chicken	
			Purchase	Sell	Purchase	Sell	Purchase	Sell
Adana	Kayışlı (IR,25H/H)	ton		189				
		ton per trade		47.25				
		No. of trade		4				
	Abdioğlu (IR,24H/H)	ton						
		ton per trade						
		No. of trade						
	Kılıçlı (RF,25H/H)	ton		67		15		
		ton per trade		8.38		15.00		
		No. of trade		8		1		
	Belören (RF,26H/H)	ton	28	53				
		ton per trade	9.33	7.57				
		No. of trade	3	7				
Konya	Alemdar (IR,25H/H)	ton					7	
		ton per trade					7.00	
		No. of trade					1	
	Beylerce (IR,16H/H)	ton						
		ton per trade						
		No. of trade						
	Çeşmelisebil (RF,21H/H)	ton	4		2	6		
		ton per trade	2.00		2.00	6.00		
		No. of trade	2		1	1		
	Karakaya (RF,22H/H)	ton						
		ton per trade						
		No. of trade						
Total (184H/H)		ton	32	309	2	21	7	
		ton per trade	6.40	16.26	2.00	10.50	7.00	
		No. of trade	5	19	1	2	1	

Source: Survey data

Table 6 shows the value and price of livestock manure traded. From this table, it can be seen that the price range of livestock manure is wide among species. This is because of the difference of function of livestock manure by each species. Generally, chicken manure is the best as fertilizer and most popular among livestock manure[8], and so the price is most expensive. Of course, farmers can get livestock manure freely if there's a lot of livestock manure and the owner of the manure doesn't have any will of selling it. But this is the critical point for livestock manure market. The owner will sell their livestock manure if they knew the fact that livestock manure was disposable by sale. In many cases in our survey, a lot of farmers didn't know that kind of information and so many of them left livestock manure waste. As number of livestock manure trader increase, common knowledge about value of livestock manure will be formed and livestock manure market will be more prosperous. Furthermore, price band will be lower and narrower. Table 6 shows that the livestock manure price in Konya is more expensive than that in Adana.

8) In this time survey, most farmers actually replied that chicken manure was the best as fertilizer and they wanted to use it onto their own land. But it is difficult for them except some living near poultry farm to get certain amount of chicken manure, and so they use other livestock manure. This can be the other reason for why the number of trade in chicken manure is only a case.

It can be said that this is because of lack of information about livestock manure trading.

Table 6. Purchase and sell of livestock manure: Value

(Unit: 1,000,000TL)

			Cattle		Sheep & Goat		Chicken	
			Purchase	Sell	Purchase	Sell	Purchase	Sell
Adana	Kayışlı (IR,25H/H)	Value		1,460				
		Value per trade		365				
		No. of trade		4				
		Value per ton		7.72				
	Abdioğlu (IR,24H/H)	Value						
		Value per trade						
		No. of trade						
		Value per ton						
	Kılıçlı (RF,25H/H)	Value		980		300		
		Value per trade		123		300		
		No. of trade		8		1		
		Value per ton		14.63		20.00		
	Belören (RF,26H/H)	Value	280	680				
		Value per trade	93	97				
		No. of trade	3	7				
		Value per ton	10.00	12.83				
Konya	Alemdar (IR,25H/H)	Value					2,350	
		Value per trade					2,350	
		No. of trade					1	
		Value per ton					335.71	
	Beylerce (IR,16H/H)	Value						
		Value per trade						
		No. of trade						
		Value per ton						
	Çeşmelisebil (RF,21H/H)	Value	200		100	600		
		Value per trade	100		100	600		
		No. of trade	2		1	1		
		Value per ton	50.00		50.00	100.00		
	Karakaya (RF,22H/H)	Value						
		Value per trade						
		No. of trade						
		Value per ton						
Total (184H/H)		Value	480	3,120	100	900	2,350	
		Value per trade	96	164	100	450	2,350	
		No. of trade	5	19	1	2	1	
		Value per ton	15.00	10.10	50.00	42.86	335.71	

Source: Survey data

7.3.4. Satisfaction with Availability of Livestock Manure

As Table 4 shows, some farmers have trades to get livestock manure to input into their managed land. But according to Table 3, demand for livestock manure is by far more than availability. So, we must check whether farmers satisfy themselves or not after having transactions. So now, we add another index for the purpose of checking whether farmers satisfy or not.

(3) Actual livestock manure input (ALMI): This is actual volume of livestock manure farmers use for land improvement. We got this data from our survey.

Using this index, we can get hold of farmers' satisfaction. After the transaction, if they actually input livestock manure over their DLMI, they can be satisfied. On the contrary, if their ALMI is below their DLMI, they can be unsatisfied.

Table 7 shows the farmers' satisfactions. According

to this table, more than half of farmers in both areas never satisfy about inputting livestock manure. Furthermore, most of farmers in irrigated area never satisfy. In addition, the ratio of farmers who don't input livestock manure is more than half and that of farmers who satisfy even without inputting livestock manure is nearly half in rain-fed area. From these results, it can be said that farmers in irrigated area tend to want to input more livestock manure than those in rain-fed area. This result can be explained by the change of structure of agricultural products in irrigated area. Irrigation and introduction of chemical fertilizer/seed has brought about great changes in cropping system and farmers can plant tree crops and vegetables those need livestock manure for their quality. But on the other hand, tree crops and vegetables give farmers more profit than livestock, and pastureland and fallow land disappeared because of irrigation and introduction of chemical fertilizer/seed. So in irrigated area, there came a great difference between demand and supply of livestock manure. In contrast, farmers in rain-fed area usually can't plant commercial crops, but new chemical fertilizer/seed technology also came to rain-fed area and so farmers started to use varieties that have much better response to chemical fertilizer. As a result, farmers in rain-fed area came to depend on chemical fertilizer heavily and the need for livestock manure decreased.

Table 7. Input and satisfuction of livestock manure, by farmers

		Input livestock manure	Don't input livestock manure	Total
Rain-fed villages (94H/H)	Satisfied H/H	9	20	29
	Not satisfied H/H	22	24	46
	Total	31	44	75
Irrigated villages (90H/H)	Satisfied H/H	2	2	4
	Not satisfied H/H	30	26	56
	Total	32	28	60
Total (184H/H)	Satisfied H/H	11	22	33
	Not satisfied H/H	52	50	102
	Total	63	72	135

Source: Survey data

7.3.5. Inter-City Area Disequilibrium of Livestock Manure

It becomes clear that even in city areas farmers can't get enough livestock manure to input into their managed land. And then farmers try to have inter-city area transactions. But we must be careful not to forget the heaviness of livestock manure. At this time survey we couldn't get detailed information about inter-city area trades and livestock manure traders who carry livestock manure instead of farmers. But livestock manure traders exist actually and livestock manure traders answered that livestock manure trading is very profitable because farmers who plant tree crops and flowers those need livestock manure a lot for their quality buy livestock manure from traders and that number of traders is increasing.[9] This means farmers who buy livestock manure from traders think that value of livestock manure is higher than the cost to buy and input livestock manure.

7.4. Logit Estimation of Livestock Manure Input

From the former session, it is found out that demand and supply of livestock manure is out of balance. Then, how farmers decide to input livestock manure or not. Table 8 is the outcome of logit estimation of livestock manure input. The explained variable is whether each farmer inputs livestock manure or not. The explaining variables are total land size each household managed (TLSIZE), whether each farmer plants tree crops and vegetables (1) or not (0) (TLMRNDCD), weighted average number of livestock

9) It is thanks to Mr. Hasan Alemdar -a villager who lives in Alemdar village- and Mr. Baran Yaçar -a Turkish side co-researcher- that I can get this information.

10) In this variable, numbers of cattle are multiplied into 5 times of originals.

(BBHB)[10], number of male laborer whose age is over 15 in each household (ENBLLBTL), whether each household has more than one tractor (1) or not (0) (TRCTRN_F), fertilizer cost per total managed land (FTPRSZ_M), whether living in irrigated area (1) or rain-fed area (0) (IRCODE), and whether living in Adana City (1) or Konya City (0) (CITYID).

From this table, decision does not rely on total land size, irrigation, and fertilizer-use, but on commercial farm products, yield and quality of that depends on livestock manure, number of livestock, number of laborer, and tractor-possession. According to this result, it becomes clear that irrigation and introduction of chemical fertilizer/seed don't have affects on decision directly but has affects indirectly by way of commercial crop production, mechanization and decreasing of pastureland and fallow land, and that farmers can't input livestock manure without capital, livestock and so on.

Table 8. The logit estimation of livestock manure input

Log of likelihood: -79.322 Number of observations: 156				
	Estimated Coefficients	Standard Error	t-Statistic	p-Value
TLSIZE	0.000	0.001	-0.310	0.757
TLMRNDCD	1.019	0.517	1.969 **	0.049
BBHB	0.027	0.008	3.487 ***	0.000
ENBLLBTL	0.587	0.310	1.892 *	0.058
TRCTRN_F	1.174	0.471	2.495 **	0.013
FTPRSZ_M	-0.034	0.023	-1.498	0.134
IRCODE	0.781	0.537	1.454	0.146
CITYID	1.244	0.549	2.266 **	0.023
Constant	-2.841	0.699	-4.062 ***	0.000

Note: *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level
Source: Survey data

7.5. Conclusions

In the section 2, we checked the flow: how irrigation and introduction of chemical fertilizer/seed influenced animal husbandry. Introduction of chemical fertilizer/seed made importance of livestock manure decreased in rain-fed area. On the other hand, irrigation and introduction of chemical fertilizer/seed reduced size of pastureland and fallow land, and changed structure of crops into commercial crops more profitable than animal husbandry. Consequently the number of livestock - supplier of livestock manure - decreased in irrigated area. From the result of this time survey, we can find the existence of farmers who cannot input livestock manure as they like; and the existence of livestock manure traders who trade livestock manure, in the section 3. From the section 4, it also can be found that the choice whether farmers actually input livestock manure or not is not influenced by irrigation and fertilizer-use directly but number of livestock, whether they own one and more tractor or not, and what kind of crops they plant. Especially, number of livestock farmers keep is very important factor; this means that the trade of livestock manure between farmers is still not so frequent.

As a whole conclusion of this report, there are two findings. At first, we can say that irrigation and introduction of chemical fertilizer/seed cause imbalance between supply and demand for livestock manure, which is important for keeping long term soil fertility and sustainable agriculture, through changing of cropping pattern and decreasing of pastureland and fallow land. To keep soil fertility and sustainable agriculture, some political support, for example livestock manure co-using union, must be had that eases effects from inequality of number of livestock or possession of tractors and helps farmers who want to input livestock manure into their land. Secondly, we find the existence of livestock manure traders who mediate livestock manure between farmers who want it and farmers who want to dispose it. This movement is not so active still now, so other political support is also needed that helps market trading of livestock manure more active

to coordinate supply and demand for livestock manure.

7.6. References

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