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THE EXTENSION OF FASCIOLOSIS CONTROL STRATEGIES (FCS): THE CONSTRAINTS LIMITING SUSTAINED COMPLEX INNOVATION ADOPTION

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ABSTRACT

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Fasciolosis disease (liver flukes) is found in cattle and buffalo caused by *Fasciola gigantica*. *F. gigantica* is unspectacular or asymptomatic disease, and reduces cattle performance in terms of weight gain, fecundity, and power. Total economic loss due to liver flukes is about Aus $63/animal/year or 347,000 rupiah. This economic loss is financially important because it is equivalent to 13% of the total annual household income of small farmers amounting to 2.6 million rupiah. Farmers and local government are not aware about the existence of the disease. In 1996, researchers found possible solution to the disease, called Fasciolosis control strategies (FCS). The main objectives of this paper were: 1) to describe the FCS extension process; 2) to convey the results of the current adoption of the FCS; and 3) to investigate and interprete the constraints limiting sustained adoption. Mixing methods were used to collect and analyse data. Results showed conventional linear top down extension model, Transfer of Technology (TOT), was applied in the extension of FCS. The success in the adoption of FCS technology was only limited since it was not sustained in the long term. The primary constraints to TOT model were identified including technology characteristics to which a complementary solution was proposed to sustain the adoption of the innovation in the long term.

Key words: Extension, fasciolosis, constraints, adoption of innovation, transfer of tehcnology

INTRODUCTION

The concept of adoption and diffusion of innovation (Rogers, 1995; Rogers & Shoemaker, 1971) is rooted in the Transfer of Technology (TOT) model, a linear approach of extension (Sumberg *et al*., 2003) from Research, Development and Extension (RD&E) to farmers through extension agents (Chamala *et al*., 1999). The linear TOT model has been used to depict the innovation adoption process and has provided a theoretical framework to understand adoption behaviour. The first part of this paper describes the historical background of the linear extension process of the Fasciolosis control strategies (FCS). The results of the adoption decisions are presented followed by an interpretation of the reasons for non-adoption.

Based on the linear model of extension, the TOT process can be categorized into three phases (Douthwaite *et al*., 2002; Rogers, 1995): 1) pre-development and development phase; 2) to start-up phase; and 3) adoption phase. The TOT process for FCS technology is illustrated in Fig. 1. The pre-development and development phases consists of the invention phases where researchers in the R&D team (without extension) in Research Institute for Veterinary Science (RIVS) in Bogor developed new research technique in the laboratory. At the start-up phase of the innovation adoption (Douthwaite *et al*., 2002), the extension agent was involved to transfer the technology to the field.

Researchers bring the innovation to the farmers, as a first 'commercial' sale, where progressive farmers start to adopt[1] (Arnon, 1989; Rogers, 1995; Roling, 1988) through District Agricultural Extension Agents. The adoption and diffusion phase occurs when progressive farmers start to apply the new technology which then extends to other farmers either through observation or word of mouth. These phases are used to analyze the extension process of the FCS technology sets, which consists of 6 strategies (Suhardono & Adiwinata, 2001b; Suhardono *et al*., 1996a; Balitvet, 2001; Suhardono *et al*., 1996b):

[1] Kremer argued that the term of adoption means that the new practices have institutionalised and applied as routine activities. Therefore, the term of 'adopters' is inconsistency to farmers who have stopped to adopt, so that they should not called 'adopters' but 'trial users'.

1. Feed only the top two-thirds of freshly cut rice stalks and cut 20-30 cm above the water level to avoid the risk of injecting *metacercaria*. *Cercaria* encyst as *metacercaria* on the immersed lower third of rice stalks or sink to the bottom.
2. Before feeding the lower third of rice stalks to cattle, the stalks should be exposed to sunlight for 3 days to kill *metacercaria*.
3. Prevent animals grazing in rice fields adjacent to a village or cattle pen for a month after harvest, to reduce their risk of ingesting *metacercaria. Lymnaea rubiginosa* in fields close to villages (<200 m) and cattle pens have a much higher prevalence of infection with *F.gigantica* than those in far away from fields. Cattle dung (containing eggs of *F.gigantica*) is used as fertilizer in rice fields, especially those near cattle pens and villages.
4. Before using cattle (or buffalo) dung as fertilizer in rice fields, mix it with duck or chicken manure naturally infected with *Echinostoma revolutum.* Copeman (1988) developed an elegant biological control strategy. By placing 5-10 ducks in a pen over the sluice from the cattle pen, or by mixing duck and cattle faeces, larval *Echinostomes* from avian species can be used to attack other larval flukes in their snail hosts, leading to parasitic castration of the snails. This will promote maximum competition between *Echinostomes* and *F. gigantica. E. revolutum* will also displace an existing infection with *F. gigantica* in the snails. Infection of *L. rubiginosa* with *E. revolutum* will sterilize the snail, prevent infection of the snail with *F. gigantica*, and aggressively displace any existing infection with *F. gigantica* from the snail.
5. As the host of *F.gigantica,* most snails die during dry season due to the high temperature and unavailability of water. Thus, treating cattle with the *anthelmintic* '*Triclabendazole'* in July or August each year, about 6 weeks after harvesting the second season rice crop provides an excellent level of control. This treatment will kill the fasciolosis at all ages in cattle, so that cattle dung will be free from the disease.
6. Compost cattle dung before using as natural fertilizer to the rice field. Compost temperatures exeeding 40^0C will kill the fasciolosis eggs in the cattle dung

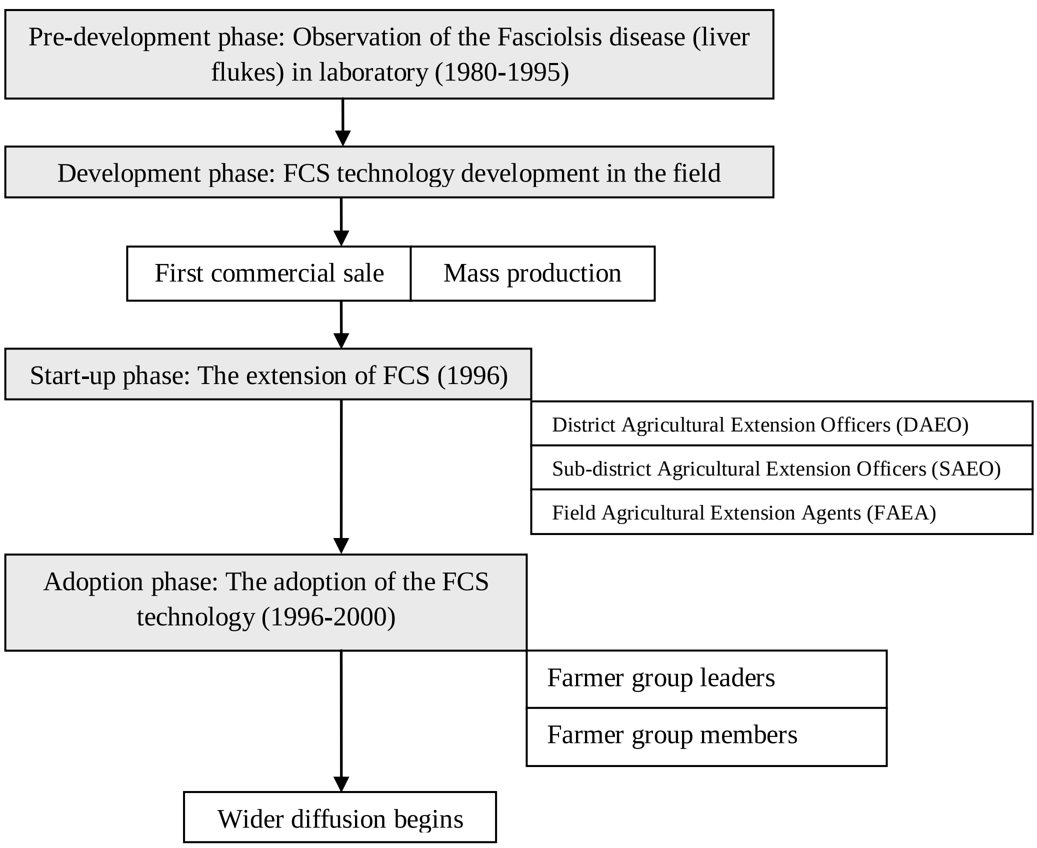

Fig. 1. The TOT model of extension of the FCS based on the Training and Visit systems (adapted from Chamala *et al.*, 1999; Douthwaite *et al.*, 2002)

The first fifth of these components (from number 1 to 5) were recommended in 1996 whereas number 6 (composting) was recommended in 2001. Number 1, 2 and 3 are called feeding and grazing strategy. Number 4 and 6 are called cattle manure control strategy, while number 5 is called drug control strategy.

The objectives of this study were determined as follows: 1) to depict the process of adoption of FCS on farm level; 2) to evaluate the change of knowledge, attitude and skill of farmer to practice FCS as well as its implication on the prevalence of FCS; and 3) identifying the constraints of FCS adoption.

METHODOLOGY

This research is called participatory action research. Mixing methods in were used to gather the data. Semi structure questionnaire was designed by researcher, extension agent and farmer leaders to conduct in-depth face to face interview with 24 households. Researcher was assisted by selected interviewers who understand and use local culture, language, and dialect. In addition, group discussion was applied with 3 farmer groups, extension agents at district and sub-district level. Data were analysed using triangulation principles in terms of various approach, researcher, theoretical perspective and method. This main purpose is to compare, contrast and cross-check data by employing a diversity of qualitative and quantitative methods (Midgley, 2000).

RESULTS AND DISCUSSION

The extension process of the FCS

Pre-development and development phase (1980-1995)

The original idea of the FCS came from Research Institute for Veterinary Science (RIVS) who have intensively observed fasciolosis disease since the 1980s in Surade, Western Java. This area was chosen because of the high prevalence of infection among village draught cattle (Balitvet, 2001; Roberts & Suhardono, 1996).

Basically, the major tasks of the RIVS are to produce 'highly specified[2]' technology (Sumberg *et al*., 2003). During the research process, the R&D team used combination methods of inquiry such as abattoir surveys, faecal egg counts, tracer animals, snail studies and anthelmintic trials (Roberts & Suhardono, 1996; Suhardono & Adiwinata, 2001a; Suhardono & Adiwinata, 2001b; Suhardono *et al*., 1996a; Suhardono *et al*., 1996b; Suhardono *et al*., 1996c; Suhardono *et al*., 1996d). Farmers were not involved because they have no formal scientific expertise to observe phenomena such as the eggs of *F. gigantica* in the cattle manure, the *F. gigantica* larvae in the water or the cercaria or *E. revolutum* in the snail (*Lymnaea rubiginosa*).

Start-up phase (1996)

The pre-development and development stages were focused on the *research problems* that are technological-centered. In contrast, the start-up stage is focused on *farmers and their problems* and is farmer-centered. In early 1996 the extension research of FCS involved parasitologists, epidemiologists from the RIVS and rural extension scientists called the RD&E team. The role of the District and Sub district Livestock Officers is to transfer the FCS technology to the farmer group.

The RD&E team and extension specialist from district level then visited four farmer groups[3] at four villages. The RD&E team stayed two days in each farmer group to introduce the FCS by using discussion, local radio broadcasting, leaflets and flip chart. In the process of extension, farmers were divided into two or three sub-groups to discuss it. Then, the RD&E team handed over the FCS activities to farmers. However, low group maturity (Chamala *et al*., 1999; Wahjosumidjo, 1994) might cause farmer group to be very dependent on external instruction and material assistance.

Adoption phase (1996-2000)

Six months later (August 1996), the RD&E team designed a post-test open-ended survey instrument and visited selected villages to conduct interviews. Evaluation results showed that the knowledge of farmer group members about the FCS had increased significantly to 80%. However, only three of five FCS were accepted by farmers; the other two were rejected in 1996.

The main reason was farmers got itchy when mixing duck manure and cattle dung. The other reason was unavailability of the drug in the village. This indicated that the FCS was still nascent rather than a mature technology. The focus of the problem was not only in the technical but also social aspects. In contrast to the previous FCS extension in 1996, at the end of 2000, I was involved as a social scientist to be part of the RD&E team. Then, I started to work with farmers, researchers (RIVS), policy makers and extension workers. Results: Level of adoption of the FCS (2001)

Before facilitating the collaboration learning and action between farmers, science (RIVS), policy and extension, evidence of FCS adoption was investigated in four indicators: knowledge, attitude, practice and the prevalence of the fasciolosis disease. The information of

[2] Sumberg et al. (2003) identified three types of technologies: 1) highly specified or commercial or mass-market technologies (i.e. vaccine or pesticides); 2) systems technologies (i.e. integrated pest management, integrated agro-forestry); and 3) defensive or indigenous technologies (i.e. traditional crops/local staple food).

[3] In general, Farmer group is a name for farmer's organisation based on various commodities (i.e. rice, livestock, soybean, seed multiplier, fish, and food security) and mostly formed by government intervention project/programs. It is possible that a farmer can be included into several group members.

farmer awareness, knowledge, attitude, and skill about FCS (see Table 1) is important as: 1) evaluation material to the previous extension activities that has been done since 1996; and 2) a benchmarked input to the next research activities used as complementary solution to the current problem.

The Change of Knowledge, Attitude and Skill

Knowledge level

Most farmers or more than 83% (see Table 1) knew about cutting and drying control strategies. About half knew about drug and grazing strategies. A quarter knew only about the cattle manure control strategy. Compared to the 1996 data (see Martindah *et al.*, 1988), the percentage of farmers who knew about the FCS had decreased substantially in 2001, except for the cutting and drying strategy. The FCS is effective if it motivates all farmers collectively rather than a few individual farmers. The reason is that crops and livestock have a "common property" environment, with no distinction between infected and uninfected cattle which have access to the same water and grazing areas. Each farmer needs to know these fasciolosis control strategies, but most farmers did not know these FCS components completely.

All FCS components are complementary, so farmers need to know each component. Figure 2 showed that none of the farmers knew all six strategies. There were 42% farmers who knew 4 or 5 strategies, while the other 58% farmers knew 1-3 strategies only. This implies that most farmers lack knowledge about the FCS as a complementary component. For example, farmers may cut off the stalk before feeding to cattle but fail to isolate cattle from feeding infected rice stalk in the harvest areas.

The source of the FCS information to farmers was mainly from the RD&E team and Livestock Agents[4] accounting for 79%. The role of the farmer as the source of information was still low, i.e. only 21% knew the FCS from farmer group meetings. None of the farmers mentioned that knew the FCS from local radio program, which is reported as the useful channel and extension method in 1996 (Martindah et al, 1998). In contrast, the main source of information was not from farmer group meetings and local radio programs, but researchers and livestock agents.

The other fact was that Field Agricultural Extension Agent or extension workers were not involved in the 1996 extension because they worked for food crops which are different activities from livestock. The problem was that Livestock officer and Extension workers lack of synergy both at district and sub-district level.

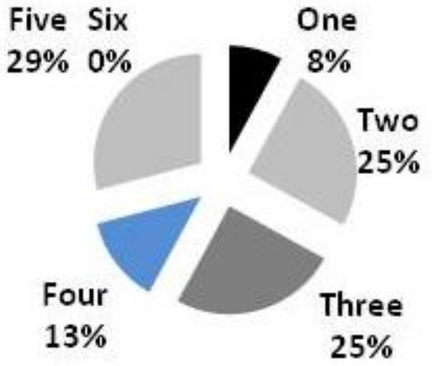

Fig. 2. The distribution of farmer knowledge about the FCS (Girsang, Fieldwork, 2001)

Attitude of the farmers

Based on the previous Table 1, majority of the farmers or more than 79% agreed in cutting, improved compost and drying strategies. About half of them agreed grazing and mixed manure strategy, whereas 75% doubted the quoted price of the drug strategy.

Basically, the willingness to accept FCS was higher among the farmers. This was possible because during an open interview, farmers asked and received new knowledge and understanding about the strategy. Farmers' willingness to accept became higher than their knowledge.

Culturally, farmers prefer to agree rather than to refuse new recommendation from external organisations. Farmers tend to say yes rather than no to new recommendation from government institutions. The main evidence of refusing new recommendation can be seen from the practice level of the new technology on the farm.

Low practice level

Practice means farmers have changed their behaviour to apply new FCS technology as a routine activity. In fact, the percentage of farmers who knew and accepted was lower than the percentage of farmers who practised the FCS (see Table 1). The evidences of the practise level could be derived based on three indicators: 1) cattle manure control strategy; 2) feed and grazing strategy; and 3) drug control strategy. This implies that nothing happen without action. Knowledge is important to produce understanding but knowledge is less important without changing attitude and skill. These three practices need to be discussed as follows.

[4] Sub-district Livestock Agent (SLA) works under District Livestock Agency. The main role is for livestock technical and disease services such as injection, drugs usage and artificial insemination. Field Agricultural Extension Agent (FAEA) works under District Food crop Agency (DFCA). The basic role is to facilitate farmer group to help themselves. They have experienced in Training and Visit approach and also in Integrated Pest Management approach. In fact, DLA and FAEA lack coordination and synergy.

Table 1. The distribution of farmer response (%) to each component of the FCS

Fasciolosis control strategies[a)]	Knowledge[b)]	Attitude[c)]					Practice[d)]	
		5	4	3	2	1	Yes	No
1. Cutting of rice stalk 20-30 cm from bottom level	96	58	42	0	0	0	92	8
2. Drying rice stalk 3 days on the sun continually	83	41	38	8	13	0	46	54
3. Avoid grazing cattle in harvest areas	54	16	50	13	21	0	21	79
4. Improved compost	25	21	79	0	0	0	13	88
5. Mixing cattle dung with chickens or duck manure	38	21	37	21	21	0	17	83
6. Use anthelmintic drugs	42	4	21	25	46	4	29	71

Source: Girsang, Fieldwork, 2001 (n = 24 households)

a) In the beginning of the extension of FCS, there were 4 strategies: 1) Cutting rice straw 20-30 cm from ground level, and drying rice stalk 3 days continually on the sun; (2) Avoiding grazing cattle in the rice field during and one month after harvest season; (3) Mixing cattle dung with duck manure before using as natural fertilizer for the rice crop; (4) Use anthelmintic drug in dry season, July or August. Based on the life cycle of the F. gigantica and the complexity and reality in the field, these FCS have been modified and categorized into these 6 strategies as shown in Table 5.1. These strategies can be separated into 3 forms: (1) Cattle manure control (improved compost and mix cattle dung with duck or chicken manure); (2) Feeding and grazing strategies (cutting, drying and grazing strategy); (3) Drug control strategy (use anthelmintic drug). The other reason for this categorization was based on close relationship between these FCS components. Improved compost and mix cattle dung with duck manure (cattle manure control) relate to the cattle dung. Cutting, drying and grazing relate to the rice stalks. Cattle manure control and feeding and grazing control strategies are focused on the outside cattle, while drug control strategy (use anthelmintic) is focused on the inside cattle (bile ducts). It is assumed the strategy (1) and (2) which is resource local based will be more prioritised than strategy (3).

b) Knowledge was measured by asking farmers to what extent they knew, remembered and were able to mention one or more of the FCS.

c) Attitude was measured by using Likert‘s scale: (5) Strongly agree; (4) Agree; (3) Not sure; (2) Disagree, (1) Strongly disagree, to measure response to ‘Attitude’ statement

d) Practise was measured by asking farmers to what extent they have ever (often) practised each strategy in their farm. This information was cross check through field observation in order to know to what extent farmers practised in the farm.

Cattle manure control strategy (CMCS)

It can be seen in the previous Table 1 that improved compost strategy was practiced by only 13% of the farmers, while mixing cattle dung and duck manure strategy by 17%. These data show that most farmers decided not to practice improved compost and mix duck manure and cattle dung strategy.

Approximately 75% of the farmers built a cattle pen beside the rice field and house, and more than half allowed the cattle dung to flow from cattle pen to the rice field. The cattle dung has no roof cover, and possibly flows to the rice field in the heavy rainy season. Data also showed that all low strata farmers and about 66% upper strata farmers placed cattle manure beside the cattle pen (Table 2).

According to farmer group leaders, cattle dung is a good fertilizer for soil and crops. The usage of cattle dung was conditional. During the dry season, some farmers gather the cattle dung beside the cattle pen and then spread into the rice field. The availability of household labour is a necessary condition whether or not farmer transports the cattle manure from cattle pen to various distances in the rice field. During the wet season, cattle dung is wet and heavy, so farmers flow the cattle dung from cattle pen into the ditch/canal/rice field as the source of fasciolosis disease to cattle.

Extension agents stated that even though some farmers had been informed about the improved compost, they were not aware that infected cattle dung with fasciolosis disease is a serious threat to cattle performance. In addition, District livestock agents and staff stated that farmers believe the disease exists if they have seen significant negative impact in the draft cattle performance, i.e. weight loss.

Feeding and grazing control strategy (FGCS)

The feeding control strategy comprises cutting and drying rice stalks for cattle feed. The cutting strategy was practised by 92% of the farmers whereas drying and grazing strategies were practised by only 46% and 21%, respectively.

Cutting off rice stalks for cattle feed has been a tradition to farmers. In fact, the practice of this strategy on the farm is conditional for several reasons. First, harvest labourers usually use a sickle to cut off the bottom part of the stalks. Second, harvesters need longer stalks to thresh the paddy manually. And third, farmers need longer stalk to transport by *sundung,* from the rice field to cattle pen.

Table 2. The place for and use of cattle dung according to farm size strata

Farm size strata	Cattle manure place			Cattle manure use	
	A	B	C	Rice	Non-rice
Lower (<0.5 ha)	100	0	0	100	0
Upper (0.5+ ha)	66	26	8	45	56
Total	83	13	4	74	28

Source: Girsang, Fieldwork, 2001
A=Cattle dung is gathered beside a cattle pen in a place without a hole or roof; B= Cattle dung is gathered beside a cattle pen in a place with a simple hole; C= Cattle spreads around the cattle pen.

Table 3. The distribution of farmers who practised grazing strategy based on land size

Strata: Size of land	Avoid grazing cattle in the harvest areas [a] (%)		Grazing cattle in the harvest areas (%)
	1st harvest season	2nd harvest season	
< 0.5 ha	27	27	73
≥0.5 ha	47	57	78

Source: Girsang, Fieldwork, 2001 [a] Grazing harvest areas is recommended <200 m from the pen

Table 3 shows that more than 73% of farmers graze their cattle in the rice field during the harvest seasons. Grazing in the rice field during and after the harvest time is part of the crop-livestock farming system because settlement, cattle pens, and grazing areas are integrated.

Grazing location changes any time, from one rice field to the other where grass or water is available. In the wet season, farmers tether cattle in the rice field during the time of land preparation, and also during and after harvest time. In the dry season, cattle were tethered in the rice field during and after the harvest season. This occurred because water and grass were unavailable and the rice field was uncultivated. In practice, cutting rice stalks and avoiding grazing cattle in the harvest area, are contradictory practices. On one hand, farmers practise the FCS by cutting rice stalks in the harvest area, but they negate such efforts by tethering cattle in the same harvest area where cattle may eat infected rice stalks.

This implies that farmers cut rice stalk for traditional reason rather than for FCS. Therefore, cutting and grazing strategies should be practised simultaneously because both are complementary. Cattle get infection when feeding on infected rice stalk whether in the cattle pen or in the rice field.

Drug control strategy

This strategy was the last alternative when feeding and grazing strategy and/or cattle manure control strategy have not been practised completely and collectively. Approximately 29% of farmers said that they had once practised the *Triclabendazole* before 1996. During that time, they received free drug from researcher and this was for institution research purpo ses only. However, when the research work was completed, none of the farmers ever used the drug from 1996 to 2000.

The prevalence of fasciolosis disease

Farmers raise more than 80% female cattle because of their multipurpose roles as the source of power and for calves and meat purposes. Adult and young female cattle have the same opportunity to get infected due to the same feeding and grazing pattern. Based on cattle age, the prevalence of adult cattle was higher than younger cattle of one to two years old. The prevalence of fasciolosis indicates the existence of the fasciolosis disease in cattle. If farmers continued to practise these FCS components, the prevalence should decrease considerably.

Table 4 shows that the prevalence of the fasciolosis varied between villages, cattle pen location, cattle age and sex. For adult and young cattle it was higher in Wanasari (74%) than Kadaleman (39%) village. This is in the interval range of the national prevalence of fasciolosis disease in Indonesia which varied between 25% and 100% (Spithill & Dalton 1999). The prevalence of fasciolosis among cattle, held in a cattle pen near the rice field where cattle dung flowed to the rice field, was higher than cattle held over 200 metres from the rice field. This means that the farther the cattle pen from the rice field, the lower the risk to cattle of fasciolosis infection. This is not a sufficient condition to remain un-infected for non-infection cattle, because cattle possibly consume feed from infected stalks areas.

The constraints limiting sustained adoption

Based on the reviewed literature (Floyd, Harding *et al.* 2003; Frank 1995b; Rogers 2003; Sumberg, Okali *et al.* 2003), the three major constraints to sustained adoption can be categorized as: 1) intrinsic; 2) technology characteristics; and 3) extrinsic.

Table 5 illustrates the specific constraints to sustain the FCS extension and adoption for developing critical analysis. These constraints to sustained adoption are complex and interconnected and need to be seen from various perspectives.

Table 4. The prevalence level of fasciolosis disease based on cattle characteristics

	Kadalaeman village				Wanasari village			
Cattle Characteristics	N	%	Prevalence (%)		N	%	Prevalence (%)	
			Positive	Negative			Positive	Negative
Total cattle treated	59	100	39	61	36	100	74	26
Sex								
Male	12	20	42	58	4	11	75	25
Female	47	80	40	60	32	89	69	31
Cattle pen location								
Beside rice field [a]	18	31	50	50	10	28	60	40
Over 200 m from the pens	41	69	37	63	26	72	77	23
Cattle age								
<1 year	4	7	25	75	0	0	0	0
1-2 year	15	25	20	80	11	31	55	45
> 2 year	40	68	50	50	25	69	80	20

Source: Girsang, Fieldwork, 2001. [a] The distance is about 1-10 m from the rice field

Intrinsic factors

Intrinsic factors consist of farmer access to resources inside and outside the village. These were defined in terms of labour and time, material and money (financial) and also involvement in group association.

Limited household labour and time

During the first harvest, farmers spent most of their time in the harvesting, land preparation and planting for the next or second planting season. Based on the season and planting pattern, these seasons occur at the same time, that is, during the rainy season in February and March. This is a critical moment where farmers have - high labour demand for rice crop activities while at the same time they need to practise the FCS.

Table 5 shows that labour demand varied from 42 to 198 or an average of 111 man work days, in accordance with the size of rice land. Farmers would make a rational decision based on their perception about the relative advantage from the FCS.

Figure 3 shows that farmers need at least 93 man work days for seed preparation, harvesting, land preparation and planting. These activities have to be completed at the same time and in the short time-February and March.

A farmer household consists of 4 family dependents, but only two of them (i.e. parents) are the source of effective labour. Young children focus on study or housework activities while adult children usually prefer to work in non-farm activities. A reasonable conclusion could be that the actual household labour available is about 100 man working days[5] during February and March. This implies that farmers have to spend 94 of 100 man working days (94%). Under this condition, farmers have to decide not to practise FCS on the farm. Furthermore, upper strata farmers have more land but they lack not only family labour but also cattle. On the other hand, lower strata farmers have small size of land but have higher number of household labourers.

Figure 4 shows that if each farmer household labour has an average of about 100 man work days (average), the first and the second higher strata farmers (S3 and S4) have labour scarcity of about 98 and 25 man work days (or total: 123 man work days). In contrast, the first and the second lower strata farmers (S1 and S2) have a labour surplus of about 33 and 58 man work days (total: 91 man work days). In short, upper strata farmers have labour scarcity of about 123 man work days whereas lower strata farmers have labour surplus of about 91 man work days. Does this mean that lower strata farmers with higher numbers of cattle have allocated their labour surplus for the FCS implementation?

Lower strata farmers are the source of labour for the upper strata farmers for planting and clearing activities. However, when human labour was unavailable, the upper strata farmers use hand tractors for land preparation. The main reasons are: (1) they have cash to pay for a hand tractor; (2) they have larger area of land which is more relevant to hand tractor use; and (3) some of them have bought hand tractors through exchange with or sale from their cattle to earn income from using hand tractor; and (4) a hand tractor works faster. Farmers have to work faster for land preparation due to water scarcity in the second planting season. As long as water is available, the highest priority is rice crop, not livestock.

[5] One men working day equivalent to 7 hours, while women working days converted to man work days based on comparison farm wage, where women wage was 66% lower than men wage. Thus, if women have 30 working days, it is equivalent to 20 men working days.

Table 5. Labour allocation for rice crop activities based on farm size strata (n = 24 households)

Labour needs / Rice crop activities	Man work days based on farm size strata (S) in hectare				
	S_a =0.146	S_b =0.30	S_c =0.561	S_d =1.125	Average=0.5
1.Land preparation	**13.2**	**26.5**	**29.6**	**65.7**	**36.3**
1.1. Men	4.6	7.3	10.0	18.3	10.1
1.2. Cattle	8.6	19.2	20.3	41.4	22.4
1.3. Tractor	0.0	0.0	9.3	6.0	3.8
2. Seeds preparation	**9.2**	**12.7**	**25.0**	**20.0**	**16.7**
3. Planting	**4.4**	**7.7**	**14.0**	**17.8**	**11.0**
4. Fertilizing	2.2	2.5	4.2	5.5	3.6
5. Clearing	**2.6**	**10.8**	**14.2**	**38.0**	**16.4**
6. Spraying	1.2	0.0	0.9	1.5	0.9
7. Harvesting	**9.6**	**16.8**	**27.3**	**49.0**	**25.7**
Total for one season	42.4	77.0	125.2	197.5	110.5
Total for two seasons	84.9	154.0	250.4	395.0	221.1

Source: Girsang, Fieldwork, 2001. S =Average size of farm

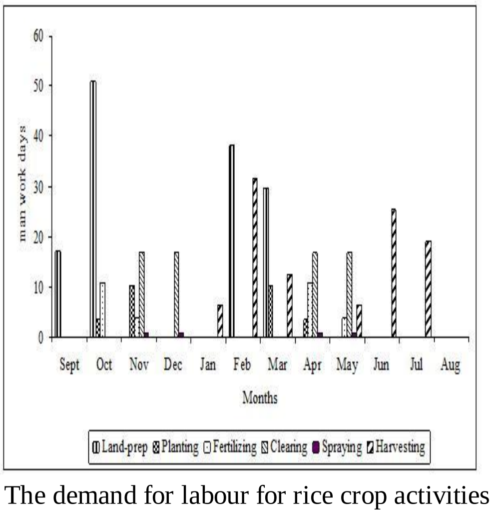

Fig. 3. The demand for labour for rice crop activities (man working days) from January to December (Source: Girsang, Field work, 2001)

Farmers may cut off rice stalks more than twice during harvest time. They also may avoid grazing cattle in the harvest area during the heavy rain but graze cattle in the rice field during the low rainfall. This implies that farmers do not practise the feeding and grazing strategy completely, continuously, simultaneously and cooperatively within and between farmer groups. They preferred to prioritize work for rice crop activities which have high labour demand.

Lack of resources and low household income

Based on the current field observation, none of the low strata farmers had ducks. Of the 45% upper strata farmers who had ducks, only 29% have had more than 5. Farmers who have ducks usually raise them extensively without a permanent coop which is built beside the house.

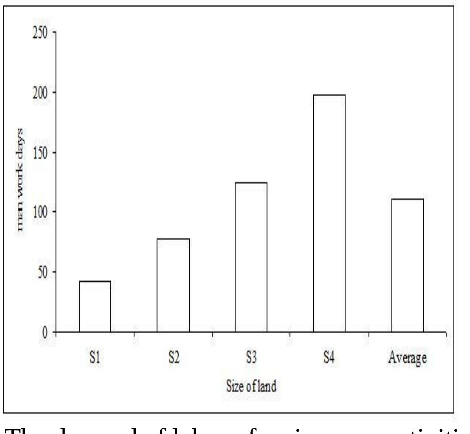

Fig. 4. The demand of labour for rice crop activities according to farmer's strata/size of land (Source: Girsang, Fieldwork, 2001). Size of land (S): S1=0.14 ha; S2=0.30 ha; S3=0.56 ha; S4=1.25 ha

The RD&E team had to provide ducks and material for duck coops to selected farmers (trial-users) during the development phase of the FCS. Unfortunately, when the research was finished, only 40% of the ducks were given to the farmers, whereas about 60% of them was collected by local livestock service and farmer group leader. Regardless of the itching (*dermatitis*) disease, the purpose of ducks assistance was research-driven rather than development-driven. The program was not continued because farmers consumed duck eggs and sold the ducks.

As with the previous strategy, farmers did not have materials to practise improved compost and drug control strategy. Drug control also consists of liquid drug (*Triclabendazole*) that was not available in the provincial level, 140 km from the village. Even though the RD&E team trained the farmer group leader to use (drench) the drug, there was no continuous effort to facilitate farmer group to link with drug sources.

The average farmer household income for four (4) people in research location is about 4,415,036 rupiahs (or US $491; 1US$=Rp9000) per year. It is about 1,103,759 rupiahs (US $123)/capita/year. This income is around the 'sufficiency' poverty line[6] (Sayogyo, 1978); that is, a boundary line to fulfil physical-basic needs particularly for staple food (exclude education and housing). The low income farmers was attributed to their weak bargaining position in off-farm and non-farm business (Saragih, 2001), high input prices and low prices of the agricultural products (Nasikun, 2000). As a consequence of low household income, farmers failed to adopt the FCS technology. Figure 5 shows that The source of household income of farmer is multiple.

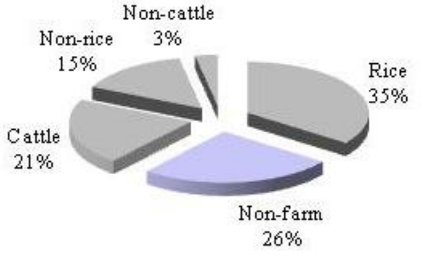

Fig. 5. Farmer household income in Wanasari and Kadaleman villages (Source: Girsang, Fieldwork, 2001)

Farmers have no saving and lack of money to pay the materials for FCS, especially for cattle manure control and drug control strategies. Besides, farmer behaviour was *risk averse* to practise new technology because of prohibitive costs and unspectacular relative advantage of new technology compare to the old practice. Rice is the major source of household income which is available about twice a year. The other income sources have the same important role to contribute to household income.

Low farmer group performance

Institutional development is the key success factor of the extension of the FCS. Farmer group is farmer institution and organization as a unit of production, cooperation and exchange experiences among farmers. To what extent do the farmer groups have collective action to solve the prohibitive costs?

The performance of the farmer group can be identified from several indicators (Chamala *et al.,* 1999; Chamala & Keith, 1995) such as how was the group formed, what was the farmer's motivation to enter the group and how farmers were being active in the group. Based on field observation, farmer group performance can be identified as follows: 1) the internal motivation to enter a group was to receive government aids and/or culturally to honour the extension agents, who acted as representatives of local government; 2) extension approach was dominantly linear from agricultural agents to farmer group. About 83% of the farmers said that the farmer group was formed by agricultural agents and rural leaders. Farmer group leader was selected by livestock officer. Most of the farmer group leaders have to work without adequate resources, including financial and material facilities. As a consequence, their activities are fully dependent on the instruction of the local agricultural agents. The main government role is regulator (Ashton, 1999); 3) most of the farmers (88%) knew that there was irregular meeting once in the last six months (June 2000-January 2001), but only about 6% of them attended the meeting. Farmers would like to come when there was material assistance in the group; and 4) farmers show their rejection through unchanged behaviour on farm.

Local field agricultural, livestock and forestry extension workers have noted that the motivation of farmers (and local government staff) in rural communities has changed from non-material (volunteer) to material (economic reward) values. This situation can be depicted as follows:

> Farmers were reluctant to come to the farmer group meetings voluntarily. They were dependent on free aid from the agricultural agency. Now, local government has no money to pay the operational costs of agricultural extension. As a result, not only extension workers are dependent on external financial assistance to enable them to visit the farmer group meeting, but also farmers tend to come to group meeting only if there is free assistance, at least for their transportation costs (IW & AG, Livestock, Crop and Forestry Extension officer, 2002).

Bridging group networks with external organizations might influence the trust, cohesiveness and good relationship that had existed within the group members (Krishna, 1999). Rice store association (*lumbung desa*), called "mini insurance company", was an institution at against poor harvest and food scarcity during the dry season. However, this institution has vanished since government controlled the price of rice through the national rice buffer stock institution (Badan Urusan Logistik). Farmer group, which consists of revolving cattle program and the FCS, could be observed in the research sites as follows: 1) low transparency, low trust, high social jealousy among the members; 2) lack of volunteer behaviour which makes it increasingly more difficult to find new volunteers in the farmer group members; 3) group leader and local livestock officer

[6] Poverty line is equivalent with 320 kg of rice/capita/year in rural areas. If the current price of rice is 2500 rupiahs/kg, the poverty line income/capita is 800,000 rupiahs/capita/year.

control power upon group decisions and rules; and 4) seeking individual self-profit becomes more important than developed collective action for group needs. In can be argued that social capital in rural communities still exists at the hamlet level (West Java: *kemandoran*) in West Java, especially for social religious activities. However, its no longer influenced by village administration and is artificially unaffected by sub-district and district government (Tjondronegoro, 1984).

Extrinsic factors

Research driven-orientation

The RD&E team perceived that its role was to identify the problem and select a suitable research methodology. In the TOT model, it is not necessary for farmers to be involved in the research process, which comprises six steps: 1) defining research agenda; 2) development of the research proposal; 3) preparatory phase; 4) implementation; 5) analysis of the results; and 6) results dissemination (Kanji & Greenwood, 2001). Furthermore, Kanji & Greenwood (2001) stated five modes of participation in conjunction with research and researched relationship: 1) compliance; 2) consultation; 3) cooperation; 4) co-learning; and 5) collective action.

Based on observation and triangulate measures support the argument that the degree of farmer group participation during the research process for the FCS was compliance. This implies that farmers not involved in the research process and researchers decided all research activities. Farmer group is dependent on external intervention to run their activities.

Fail to grasp local farmer needs in a complex environment

Research driven orientation failed to grasp local farmer needs. Unlike the RD&E team who perceived the FCS as the main priority to improve cattle performance, farmers perceived that feed shortage during the dry season was the main priority problem for cattle. Another priority problem was the lack of male cattle. Fasciolosis disease, which was perceived by farmers to be like the other worm diseases, was recognised by only 24% of the upper strata farmers only (Table 6).

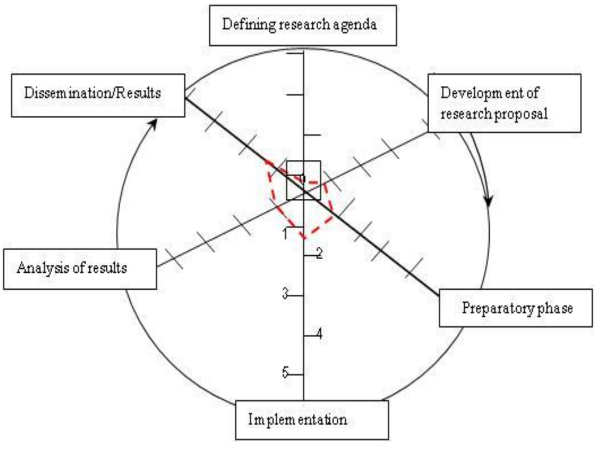

Fig. 6. The degree of farmer group participation in FCS research

------ The boundary line shows the degree of farmer group mode of participation: 1=compliance; 2=consultation; 3=cooperation; 4=co-learning; and 5=collective action

In the dry season, rainfall is low and rice field dries without green grass, particularly in June, July and August. Besides, male cattle became more important when artificial insemination is unavailable or was a failure. In difference to agricultural agents, farmers showed that disease control program links with other farm problems: chemical fertilizer price, extension effort, government policy and financial institutions to support the program (Table 7).

Table 6. The priority of problem identification according to farm size strata

Problem identifications	Problem priority* based on farm size strata[1]			
	Strata of farmers		Priority of the problem	
	Low (%)	Upper (%)	Low (%)	Upper
Failed artificial insemination	0	4	0	5
Aborted	0	4	0	5
Lack male cattle	40	16	1	3
Lack of Extension service	0	24	0	1
Diarrhoea	0	8	0	4
No problem	20	20	2	2
Feed shortage in the dry season	40	24	1	1
Fasciolosis[2]	20	24	2	1

Source: Girsang, Fieldwork, 2001
[1]Farm size strata based on land occupation: < 0.5 ha is lower strata; >=0.5 ha is upper strata
[2]Fasciolosis and other worms are perceived by upper strata farmers as mixed diseases
* Based on farmers decisions

Table 7. The problems of the crop livestock farming system identified by farmers

Problems based on agribusiness sub-systems	*Farmers (%)*	*Priority*
1. Upstream agribusiness sub-system: Input		
1.1. High price of chemicals fertilizers and pesticides &drugs	50	1
1.2. Unavailability of fertilizers, pesticides & drugs	29	2
1.3. Low financial capital to buy input materials	29	2
1.4. Low seeds/calves quality	14	3
2. On farm agribusiness sub-system: Production		
2.1. Difficult to control pests & diseases	57	1
2.2. Low productivity	36	2
2.3. Water scarcity	29	3
2.4. Cattle feed scarcity	14	4
3. Downstream agribusiness sub-system: Trade and services		
3.1. Low price of agriculture products	71	1
3.2. No problem of agricultural product marketing	29	2
4. Institutional support agribusiness sub-system		
4.1. Lack of financial capital (credit) assistance from Bank	50	1
4.2. Lack of agricultural extension service efforts	29	2
4.3. Lack of government policy to empower farmers	21	3

Source: Girsang, Fieldwork, 2001

Besides, local government prioritized its disease control program on diseases which have social and political impact, i.e. *Rabies* and *Anthrax* (District DLA staff, personal com., 2002). Livestock service agency perceived that the FCS was the project of the RD&E team, whereas the RD&E team perceived that local government has the main role to transfer the FCS technology to the farmers. Based on field observation, there was no effort to nurture facilitation (extension) to farmers. The new technology will fail to sustain if it is handed over too early (Douthwaite *et al*., 2002) and there is lack of extension effort (Pretty, 1995).

Farmers also perceived that all the problems link simultaneously and holistically as part of a farming system. Farm and non-farm activities occur in a complex, diverse and unpredictable environment in terms of topography, water resources, weather, agricultural yields and prices. Farmers have no right to control pasture and water re sources which are known as "common property" (Roberts & Suhardono, 1996).

The FCS technology characteristics

Complexity

The fasciolosis disease is also called an environmental disease because it multiplies in the snails and spreads from unhealthy to healthy cattle through infected rice stalks in an the irrigated rice crop environment. The FCS is complex, consists of six control strategies which complementary with each other. The characteristic of the disease is asymptomatic, and the impact of the FCS on cattle is unspectacular in the short term. The success factor of the FCS is determined by cooperative work with and between farmer groups.

Compatibility and profitability

Feeding strategy

Farmers have traditional reasons to cut off rice stalks in the rainy season: 1) to clean the old and dirty leaves that may be contaminated with certain disease; 2) it is lighter to transport from rice field to cattle pen; and 3) to provide shorter rice stalk feed for cattle consumption. Based on field observation and group discussion, this traditional reasons motivated the farmers to cut rice stalks rather than for fasciolosis control. Besides, drying rice stalk strategy is location specific. This practice is more appropriate in a village where water and grass are unavailable in the field. Conversely, this strategy is irrelevant in the areas, where water and grass are still available, alternative for grazing land is available, i.e. Kadaleman village.

Mix cattle dung with chicken manure

In the 1970s, farmers raised ducks to get eggs and new ducks for household consumption. From that time, the problem of itching has been known by rural communities to be caused by contact with duck manure and transferred to the human body either directly or through water which might be contaminated with duck manure (DN &HRM, rural leaders, personal comm., 2001).

Culturally, farmers prefer to raise chickens which they perceived as being 'cleaner' and more profitable than ducks. In order to test the effectiveness of chicken manure as a substitute for duck manure, the RD&E team offered about 100 free-range chickens and chicken coop costs to 10 selected farmer group members in 2001. The research finding showed that chicken manure could be effective as a substitute for ducks manure but this needs to be validated because no control field was monitored (Suhardono and Adiwinata 2001a). At this stage, the R&D team took at least 7 years, from 1996 to 2002, to provide a '*mature*' feed back technology, i.e. chicken manure in response to the itching problem. Unlike Surade sub-district, the RD&E team also reported that farmers in Tangerang villages, Western Java, also reared ducks but they have not reported itching (Suhardono & Adiwinata, 2001a). In this area, farmers rear ducks intensively for market-orientation rather than for fasciolosis control.

Compost strategy

Traditionally, farmers usually clean the cattle pens and stockpile the cattle dung beside it. In the dry season, some farmers transport the dry cattle dung to the rice field. In the rainy season, farmers wash the cattle dung into the ditch or rice field.

An improved compost strategy was proposed as a treatment to accelerate the decomposition process and to produce high temperature (>40^{o}C) in order to kill fasciolosis eggs in the cattle dung (Suhardono & Adiwinata, 2001b). This improved compost strategy had not yet been practised by farmers because farmers have no resources and high used of chemical fertilizers, particularly Nitrogen/Urea (Fig. 7).

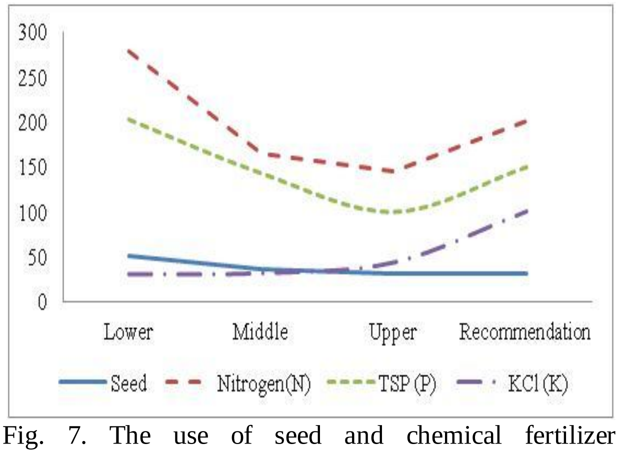

Fig. 7. The use of seed and chemical fertilizer (kg/hectare) of rice land (Source: Girsang, Fieldwork, 2001)

Lower strata farmers tend to use almost twice as much chemical fertilizer (Urea/Nitrogen) as upper strata farmers at Kadaleman and Wanasari village. Similar to the village level, the use of chemical fertilizer is inversely correlated with the area size of land at national level (Pakpahan, 1992). This suggests that small-farmers, tend to adopt a new practise which provides intangible profit in the short term (Nasikun, 2000).

Based on the field observation, each cattle produces 10 kg dung per day or 3.6 ton/2 cattle /season (6 months). This is only sufficient to fertilize 0.125 hectare of rice land. Ideally, about 20,000 kg natural compost or 5000 kg improved compost are needed per hectare of rice land (Lingga and Marsono 2000). If the price of improved compost was 300 rupiahs/kg, this is equivalent to the price of Nitrogen (Urea), as much as 200 kg/ha. At this price, it is reasonable for farmers to choose chemical fertilizers rather than improved compost for fasciolosis control.

CONCLUSION

The linear top down approach which is appropriate for simple technology in a homogenous environment was used in the extension of the FCS. Most farmer group performance in research sites was low, reactive and fully dependent on external intervention. In this context, relevant extension approach used Transfer of Technology, top down or instruction. This top down-linear extension approach is strongly inherent in the local government program and rural development policy in Indonesia. Field observation proves that top down approach causes adoption were not sustainable in the long term. The percentage of farmers who practised the FCS was *low*, ranging from 13% to 46%. As a consequence, the fasciolosis *prevalence* was high, up to 74%, though it varies between villages.

There are at least three important groups of reasons why the FCS was not sustained. Firstly, intrinsic factors include limited household labour and time, lack of material and social resources, low household income and low farmer group performance. Secondly, the FCS technology sets are complex, asymptomatic, and consists of prohibitive costs in terms of time and labour and input technology. Intangible outputs in the short term and the time lag to materialise output in the long term are other constraints to sustained adoption (Girsang *et al.*, 2002). Thirdly, researchers focused on research-driven orientation, assumptions that the research institution is the single source of technology solutions to local problems. New technology was assumed will diffuse to farmers through local government and extension agents. The other extrinsic factor includes lack of collaborative learning and extension effort to continue facilitation in a complex, diverse and unpredictable environment of the FCS.

Based on the reflection upon the constraints limiting sustained adoption of the FCS sets, a systemic, participative and collaborative learning and action approach will be implemented in the second stage (2001-2003) of the research. A continuous collaborative learning between farmer group (managers), research institution (science) and extension is proposed as an effort to sustain and improve the FCS adoption.

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