Smallholder participation in high value agro-export chains in Peru. A study of the co-evolution of technology and institutions

A.H.J. (Bert) Helmsing
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(helmsing@iss.nl)

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1. Introduction

In essence poverty is not only about lack of resources but also about the lack of opportunities. High value, tradable crops may provide opportunities to escape from what Dorward et al (2005) call a 'low level equilibrium trap' but as they observe there are important technological and institutional gaps that prevent small producers to produce for and transact in associated markets. The central question in this paper is how technological and institutional processes to overcome these gaps are interconnected. In these processes normally firms are the key players with a more or less active role of governments, but as Dorward and others have argued on different occasions for developing countries, NGOs can help overcome market and government failures in these processes (Dorward et al, 2003, 2005, Kydd et al, 2004, Helmsing & Knorringa, 2009)

We will use a case study of a Peruvian NGO and its efforts to assist small producers to acquire technological competences and develop institutional arrangements amongst themselves and with new suppliers and buyers in new agro-export chains. These efforts concern simultaneously technological change and innovation as much as the construction of new institutional arrangements.

Evolutionary growth theory has primarily focussed on technology and innovation. Central is the notion that firms use organisational routines[1] to conduct their business (Nelson & Winter, 1982). The performance of a firm will depend on the routines it possess and by those held by other firms and other actors with which it interacts, including competitors, suppliers, and customers. Many routines may be common to firms in the same line of business but some are not and these "provide the stuff that determines how firms do relative to competitors" (Nelson, 2002). Evolutionary theory has mostly focussed on technological change as a process of change in a firm's organisational routines. The generation of new routines involves processes of individual and collective learning (Helmsing, 2001). The mastery of new technology involves a process of building new routines and dropping old ones. Some firms succeed in developing new routines that generate high productivity, while other may not. The latter firms will not survive the competition.

Evolutionary theory recognizes that technological change is influenced by institutional structures, that may be supporting (or obstructing) it and may have a strong influence on the degree and speed of acceptance of new technologies into an economic system. However, evolutionary theory has given less attention to these broader and dynamic institutional issues. Of course interaction between technology and institutions supporting it is partially addressed in national and regional innovation systems literature but a broader understanding of institutions in evolutionary growth theory would be important.

Nelson (2002) made a plea to 'bring institutions into evolutionary growth theory' so as to better understand the interactions between technological and institutional change. For him, routines are the unifying concept. Evolutionary growth theory has focussed mostly on physical technologies as routines. But a set of productive routines concerning a particular technology not only applies to a firm itself but also also to a collection of procedures that guide its interactions with suppliers, clients and other actors involved in the industry. That systemic aspect of complementary routines essentially organizes the division of labour in a particular industry. This is what Nelson proposed to call 'social technologies' as modes of governance which in institutional economics are called institutions. "Markets define and are defined by social technologes. So too are widely used procedures for collective choice and action" (Nelson, ibid:22). For Nelson social technologies as institutions are "not so much 'constraints' on behaviour… but rather "effective ways to get things done when human cooperation is needed" (ibid p.22).

Institutions are thus seen as complementary to technology and help to organise the division of labour around these (new) technologies. The development of these complementary institutions can be the result of market and/or the result of collective (and public) action in which not only firms but also other actors play important roles. The co-evolution of technologies and the construction of new complementary institutions is thus a central area of concern but it is a topic that is not very well understood.

This paper looks at the process of social construction of institutions and its interaction with related technological innovation. In section 2 I will use a stylised model of social construction of institutions, developed by Gomez (2007) which draws on two schools of 'old' institutional economics, (Hodgson, 2003) and Chang, 2002, 2007) and then reflect on different aspects of that model.

By its very nature the proposed analysis is one that has to cope with complexity, as many variables interact and do so within evolved historical and geographical contexts. A case study approach is used. Within the scope of this paper it is however impossible to give a detailed account of the case and achieve also the analitical objectives that we have set ourselves. A middle ground has therefore been taken. In section 3 I will give a short overview in broad strokes of the case study. Having provided a bird's eye view of the case, I will concentrate in section 4 on the question who is the innovative agent involved in the generation of the social technology and how his prior experiences and background shaped the (bounded) rationality of his reflexive actions and the novelty thereof. The core of this case study concerns the social construction of institutional choices and their sustainability. In section 5 I will dwell on different actors being networked in a process of experimentation, the factors influencing institutional choices at the level of small producers, and constraints arising from social demands and from physical technologies. Crises and opportunities force agents to re-examine their choices and a new social technology emerged. However, institutional change is not only influenced by shocks and crises. Also the institutional arrangements that have been socially constructed may not 'fit' the circumstances and, if so, may fail from *within* or call for transformation. This will be examined in section 6. The paper will end with section 7 with some concluding observations.

2. A stylised model of social construction of institutions

This paper adopts an old-institutionalist evolutionary view to understand processes of institutional change. On the one hand I rely on social institutionalists, notably Hodgson (2003) who defined institutions as "durable systems of established and embedded social rules that structure social interaction" (Hodgson, 2004: 424). He distinguishes primary, evolved and designed institutions. Primary ones are the most resilient, evolved institutions have their counterpart in habits and routines and designed institutions which are the result of reflexive or deliberative actions and policies. Central to the social construction of institutions is the notion of reconstituve upward causation where new institutions are accepted by other groups. At the same time there are processes of reconstitutive downward causation whereby (designed) institutions are imposed from above. These may be the result of a political power struggles between powerful other groups which have differential access and control over the state. The latter is more akin to the political economic institutionalist approach of Chang (2002, 2007).

Gomez (2008) recently developed a stylised model of the process of institutional construction. The evolutionary nature of the process comes out in several ways. The model identifies four main phases in institutional construction. The first is the recognition that there is an institutional gap. This involves normally a particular agent, the innovating collective action entrepreneur, who sets in motion reflexive actions to experiment with institutional innovations. But in order to do so, this agent has to mobilise other agents, networks and resources. This experimentation is the second phase in the process. Experimentation is in itself a process of trial and error but also shaped by past experiencess and accumulated knowledge. Interaction with technology is important here. The third phase is that where institutional development moves from experiment to design and replication on a larger scale. The speed and extent of the process is influenced by a number of factors. The fourth and final phase establishes the governance of the institution, where the new institutional arrangements get a firm place in the economic system. Below we elaborate with some detail on these four phases.

a) Agents perceive an institutional gap. This gap may appear because old routines and habits do not work anymore due to external restructuring; or because of new insights or an innovative way of looking at an existing problem. This pushes the agents to engage in

reflexive actions and begin to experiment, using trial and error, creating new institutional arrangements, first within a close network of aligned agents and later expand this towards other groups; The innovating agent who seeks to introduce new arrangements among other agents, needs to have the means to convince the other agents to follow the proposed course of actions; convincing may be the result of incentives or means to coerce; in cases where coersion does not apply it is negotiated.

This expansion doesnot go automatically but is constrained and/or enabled by preexisting institutions and negotiated with other groups; especially when the innovative agent has no means to impose the new institutional arrangements (in which case it would be a top-down process); what follows is a process of reconstitutive upward causation.

In the process of reflextive actions in order to come up with new institutional arrangements, the innovative agent is bound by existing primary and evolved institutions prevalent in the area of implementation. A particular institutional 'fix' may fail when the new rules do not match with underlying evolved institutions; or, when the institutional fix relies on 'old' rules that do not match the new conditions.

b) Institutional innovation as a process of experimentation by trial and error. Through the situated (Hodgson, 1988) bounded rationality of agents concerned. Bounded rationality refers not only to limited capacity to comprehend but also because learning is shaped by pre-existing habits and routines (Nelson & Winter, 1982). Moreover, agents do not live in isolation: intentions and interest are defined in relation to other agents. Thus the intention may be efficiency enhancing, but could equally be motivated by the desire to maintain or counteract power asymmetries; or for reasons of social relations per se.

Experimentation involves imitation, repetition, and refining responses – such repeated processes of interaction between innovative agents and other networked agents help to reduce uncertainty and complexity for agents. Repetition increases grasp and creates proto-routines.

There are important conditions for such processes of innovation to become succesful. First of all, the innovative agents must be a collective action entrepreneur who also has organisation skills and ability to mobilise the group, other agents and resources; Secondly, it is critical that the innovating agent is part of a network of (complementary) agents with interests and intentions aligned with the search of new rules of action, and who can contribute tacit and formal knowledge and other resources which shorten the reflexive process and make it more effective, thereby reducing inherent risks. Thirdly, there must be a continuity loop of pre-existing institutions that set the limits on what experimentation is possible and enable search for new solutions. Any new institutional arrangement is therefore never completely new but builds on elements of pre-existing ones. Institutional experimentation involves a lot of failures for reasons of its complexity, involving multiple actors, but these failures leave footprints or traces that help newly developed trials to succeed. Crucial is the willingness to accept failure and to learn from these failures. Trust is important at early stages of experimentation.

However, as Gomez (2008) observed, poor people may prefer to stay within the continuity loop as moving to innovate through the reflexive loop is too risky for them or they lack the resources to do this and rewards may be too uncertain.

c) From experimentation to design. Initially experimentation takes place within close networks; as new solutions are accepted within broader networks that help operationalise these new solutions, sharing knowledge and costs. However this may also limit the range of possible experimentation. New institution is accepted first in that network before it becomes more widely accepted and becomes a social institution. However, this does not happen automatically: replication and expansion may require particular competencies and/or resources. Moreover, other groups may have experimented with other solutions. Moreover, these other groups may not necessarily operate with a similar intention. Dorward et al, (2005) distinguished between new institutional arrangements that are pro-developmental i.e. structuring transactions in such a way to promote investment and growth, while other may be anti-developmental seeking institutional arrangements that permit extraction of rents. Furthermore, particular groups may see new institutional arrangements as a threat affecting their position of power. The important logical conclusion is that new social institution may be efficiency enhancing but not necessarily so.

d) Creating governance of institutions. Gomez (2008) sees this as the final stage of institutional construction: the coming together of institutions. A governance system is defined as a coherent set of institutional arrangements that organises, coordinate and manage the interdependence of actors inside and across the boundaries of an economic system. In her view there are 4 criteria to assess a governance system: i) input legitimacy of rules and institutions seen as the process by which these have been constructed; ii) mechanisms of control and enforcement; iii) sustainability of the governance system (or output legitimacy), and, iv) transaction and decision making costs associated with it.
In section 4 we will reflect on this model using the case study of CTTU. But before doing so, we will present first an overview of the case itself.

3. A bird's eye view of CTTU and smallholder inclusion in agro-export chains

Table 1 below presents a time line of the main events of CTTU and its activities. The origins of the case can be traced back to the sudden discontinuation in 1988 of PROCAD, an Andean rural community development project which was led by Jesuit priest Jose de Bernardi. This unexpected end, was brought about by Sendero Luminoso's attack on the centre. It ended a succesfull adult education development practice. It also stimulated reflection on social causes of conflict during a study period abroad and led the priest to develop his ideas concerning the creation of the Center for Transfer of Technologies to University graduates (CTTU).
This new intervention model targetted graduates of the regional universities and provided them with the opportunity to become young entrepreneurs forming their own agro enterprise dedicated to the growing of high value export crop, asparagus. The intervention logic was primarily justified on political grounds: how to prevent that frustrated university graduates join the terrorist movements and in stead of "promotors of violence" become "promotors of peace". However its application was primarily economic: how to form entrepreneurs and incubate their enterprises. Crucial in the germination of ideas was a chance encounter between De Bernardi and the owner/manager of an innovative firm. The process of reflection and social construction that resulted will be elaborated in section 4 below.
In 1991 the new NGO (CTTU) was created. Additional resources were subsequently obtained from a Dutch co-financing agency which enabled CTTU to expand staff and actually start its activities. A first land holding was acquired on desert land to begin creation of agro-enterprises using advanced technology and farm management methods, developed with the 'foster enterprise'. Drip irrigation technology required a minimum scale of operation in order to be viable. Single person enterprises envisaged as part of the incubation process were too small. This problem could be addressed by creating a cooperative in which assets would be pooled. But since the collapse of the agrarian reform, cooperatives had a 'bad reputation'. Therefore it was solved by adopting a well known collective action solution: the creation of a non-profit welfare organisation. This became the Drip Irrigation Production Unit which would own the irrigation infrastructure. The first DIPU started operations in 1995 with 12 university graduates after a long struggle to locate underground water for irrigation. It achieved spectacular yields much higher than large scale agro-companies in the region had achieved so far. As the fame of the project spread to peasant communities in the valleys, these began to pressure the CTTU 'not to abandon them'. Resource conditions on peasant holdings however did not permit drip irrigation and technological constraints led to institutional adaptation. The Gravity Irrigation Producers Association (GIPA) was a new institutional arrangements created in 1995. This institution doesnot own assets but organises groups of rural higher education graduates to facilitate learning, input distribution and marketing. In the second half of the nineteen nineties a number of GIPAs were created in the Chao, Viru and Chimbote valleys.
In 1996 the Dutch donor approved a second phase of the project through which CTTU's activities are subsidised. This assured the continuation of the training programmes.

Table 1
Time line of main events, 1988 - 2008

1988	Sendero Luminoso attacks PROCAD, Jose de Bernardi Sj. went abroad
1988/89	Studies at the ISS
1990	Return to Peru – social construction and operationalisation of ideas
1990	Protagonist meets leading entrepreneur: a learning alliance is formed
1991	Creation of CTTU, Center for Transfer of Technology to University Graduates
1993	CEBEMO approves its project application for funding (1993-1995)
1993	Acquisition of the land holding 'San Juan' from the CHAVIMOCHIC project (25 has)
1993-5	First promotion of a cohort of (12) young entrepreneurs – Drip Irrigation Production Unit, DIPU "San Juan", Moche
1994	CTTU is legally constituted as 'non-profit socio-cultural association'
1995	First promotion of Gravity Irrigation Producer Association, GIPA groups (5) in Chao and Virú
1995	Second promotion of (10) young entrepreneurs – DIPU "San Martin", Moche
1996	CEBEMO approves a second project phase (1996-1998)
1996	Formation of five new GIPA groups in Chao, Virú and Chimbote
1996	Agreement with the Community of Paijan – CTTU acquires 100 has of communally held desert land
1997	First tender of land of CHAVIMOCHIC (9000 has) – large companies buy these all and start with large scale export agriculture; the regional asparagus boom begins
1997	Third promotion of (12) young entrepreneurs – DIPU "San Jose", Paijan
1997	Two new GIPAs are formed
1997	CTTU creates an agricultural enterprise "Casuarinas", Moche
1998	One new GIPA is formed and two GIPAs, formed in 1996, are discontinued
1998/9	Serious damages by heavy rains caused by "El Niño" and a drop in asparagus yields
1999	CordAid approves a third project phase (1999-2001)
1999	CTTU starts an integrated local development project in Paijan, financed by Action Aid
1999	Fourth promotion of (10) young entrepreneurs, DIPU "San Ignacio de Loyola", Paijan
1999	DIPU San Juan create a parallel Limited Company Agro San Juan SAC
1999/00	Four new GIPA groups are formed in Paijan; two GIPAs formed 1988 close down
2000	Asparagus price slump in the international market (China)
2000	Fifth promotion of (4) young entrepreneurs, DIPU "Señor de los Milagros", Paijan
2001	DIPU San Martin created Limited Company Monteverde SAC
2001	Formation of six new GIPA groups in Paijan; two GIPAs of 2000 close down
2000/1	Export boom becomes a bust: falling prices
2001	Drop in GIPAs (2) and GIPA membership (95) in Viru, Chao and Chimbote
2001	New state policies to create a plural and competitive system of BDS for agriculture
2001	Donor funded external evaluation and bridging plan
2002	NEXOS advancing a civil society perspective
2002	Recursos SA advancing a business perspective
2003	Governing Board CTTU: CTTU to withdraw from credit operations
2003	DIPU San Jose, Paijan creates limited company Agro Lider SAP SAC
2004	CTTU secures two government funded projects providing BDS services and chain coordination to contract farmers
2005/6	New model replicates among small producers and companies
2007	Financial institutions accept CTTU model for group loans under export agriculture finance scheme

Sources: fieldwork interviews and internal documents CTTU

A mayor breakthrough in addressing the land constraint to incubate advanced technology enterprises (DIPUs) was the acquisition of 100 hectares of desert land owned by a rural community of Paijan (in the North of the Department of La Libertad) on the condition that CTTU will stimulate enterprise development in DIPUs and GIPAs in the Paijan district.
Credit then became the binding constraint. Faced with market failure in the credit market, CTTU addressed this by assuming responsibility for a large loan obtained from the Canadian Counter Value Fund. The number of DIPUs and especially GIPAs increased rapidly. In order

to serve the new enterprises with high yielding varieties, CTTU set up a nursery in 1997 where seedlings were produced under more controlled conditions. Seedlings were provided as a service, free of charge, to DIPU and GIPA members.
The asparagus export boom received a big stimulus by the sale of land by the CHAVIMOCHIC project. Nine thousand hectares were sold by public tender. However tender conditions were such that only large companies could acquire land, many of which invested directly in asparagus production. The asparagus boom attracted also related and supporting industries and service providers (input distributors, sale and hire of farm equipment etc) as well as rural labour to work the fields. As a result a new export base developed within a period of five years around one single crop, asparagus and the region became a leading exporter.
In 1998/9 the "el Niño" phenomenon struck which caused heavy rains and flooding in the valleys causing damages to irrigated fields. Crop yields declined in GIPAs but DIPUs situated in the desert were not affected.
In 1999 CTTU applied again to the Dutch co-financing agency for financial support for a third period. Also this third application is succesful. In the same year Action Aid selected the CTTU to implement an integrated local development project in Paijan which was mostly focused on social development and which complemented the income generation cum enterprise development activities already undertaken by CTTU in the area. It stimulated the formation of new GIPAs in Paijan in 2000 and 2001 and a new DIPU took off. The number of applicants to CTTU grew, attracted by the high incomes earned in the export boom. The relative resource abundance of CTTU in those years resulted in less strict selection by CTTU of potential entrepreneurs. Table 2 gives an overview of the evolution of CTTU generated enterprises during this period.

Table 2
Basic data on the evolution of enterprises formed by CTTU, 1995-1999/00

	1995	1996	1997	1998	1999/00
Newly formed DIPUs	2		1		2
Number of existing DIPUs	2	2	3	3	5
Number of uni-personal enterprises embedded in DIPU	62	22	42	38	70
Newly formed GIPAs	5	5	2	2	4
Number of existing GIPAs	5	10	12	11	13
Number of uni-personal enterprises embedded in GIPA	71	141	162	145	169
Total number of uni-personal enterprises	133	163	204	183	239
Discontinued GIPAs	0	0	0	1	2
Desertion of members from DIPUs	40	30	44	30	40
Desertion of members from GIPAs	0	2	5	33	21
Total number of deserted members	40	32	49	63	61
Number of hectares under DIPU system		12	28.5	28.5	34
Number of hectares under GIPA system	16	70	180	150	186
Average annual yield (ton/ha/campaign) DIPU	-	31.7	9.0	5.9	8.3
Average annual yield (ton/ha/campaign) GIPA	3.5	5.0	5.0	4.0	4.3

Source: Wils y Benavides, 2001, Informe Evaluación Externa;
Figures on desertion among DIPUs were adjusted based on information provided by Father de Bernardi (interview, June 2006).

An aggressive Chinese export drive in the world market led in 2000/1 to a fall in asparagus world prices and hit the region before it had been able to recover from the ravages of "el Niño". The number of GIPAs as well as GIPA membership declined rapidly. Members defaulted on their loans and left the CTTU with their accumulated debts. The growth of DIPUs also stagnated as economic prospects had declined.
The new institutional arrangements and the innovating agent, CTTU, suddenly found themselves in crisis. Reflections by different related agents, operating with different missions and perspectives advocated different solutions as to how to change the model. The

institutional choices made by CTTU were influenced by three main factors: i) important changes in the broader institutional environment, notably a new agricultural policy of the Peruvian government, ii) the answer of Peruvian export firms to the competitive challenge of China, and iii) the vision of the CTTU itself of its future: non-government organisation or non-profit agent. In section 4 we will elaborate this adaptation process.

Drawing on technological innovations in transport of related horticulture exports in neighbouring Chile and adapting these to asparagus, the Peruvian firms succeeded to redefine their market niche by switching from preserved white asparagus to fresh green asparagus. Since then they have become world leader in fresh asparagus, leaving China to dominate the world market of preserved asparagus. The technological innovation in asparagus also made it easy to extend the new transport technology to other high value export crops (see below). Peruvian firms began to diversify their export crops. These new crops were annual crops (artichoke, peppers etc) reducing the high risks associated with investment in semi-perrenials such as asparagus.

Based on prior succesfull collaboration with CTTU, export companies shared their learning experiences and on that basis CTTU could relatively quickly adapt training packages to the new crops. The new 'post-crisis' contractual arrangements are a local adaptation of a contract farming model made possible under the new agricultural policy: CTTU became a chain coordinator, providing chain coordination and related services to small producers. For small producers the CTTU provided "transaction opportunities" in markets not accesible to them individually, notably in the markets for export crops, for inputs, and for credit. The risks of operating in volatile export markets were managed by means of new interlocking arrangements between CTTU and smallholder and between smallholders and export companies. In this new institutional set up, CTTU became a non-profit enterprise with a mission to serve small producers but charging for its services. Table 3 gives an overview of the growth of the new institutional model.

Table 3
Development of the new GIPA model: 2004-2006

	2004	2005	2006
Number of enterprise supply chains	1	3	7
Number of crops	1	2	4
Number of GIPAs	2	7	9
Number of producers	45	66	168
Cultivated area (ha)	66.65	139.1	426.85

Sources: Producer data sheets, CTTU, various years

How succesful has the CTTU been in its original objectives? Clearly its contribution to reducing social conflict has been marginal at best. Other factors had far greater significance. In the nineteen nineties, Sendero Luminoso's campaign of terror made them loose support from the rural population and the stepped up campaign under Fujimori resulted in the capture of its leadership. How succesful has CTTU been in its economic contribution? Also here the results are mixed: the original plan of incubation of individual enterprises in combination with a desert land colonization scheme, based on the DIPU model was, in the end, not succesful. The chosen institutional arrangement 'frooze' the incubation process, although selected members succeeded to create (independent from CTTU) new agro-enterprises with accumulated profits. CTTU has been most succesfull with the institutional model which was not originally foreseen, the GIPA, creating 'transaction opportunities' for educated children of 'parceleros' and incubating new enterrpises in the process. Its success can be explained by its capacity to adapt changing circumstances, aided by long term funding from a 'patient' donor and by having initiated an alliance with large export companies. The very transformation of the regional economy created 'a critical mass', economically and politically. In economic terms in so far that the geographical concentration of asparagus production attracted specialised suppliers and services to the region which also benefitted small producers and because large firms were able to respond succesfully to the competitive challenge created by

China. In political terms in the sense that export business leaders from the region were invited to help give shape to the new agricultural policies of the state (INCAGRO project) and because large companies were able to lobby the state for infrastructural improvements.
Table 4 gives an overview of the status in 2008 of all incubatees since 2000.

Table 4
Status in 2008 of incubatees since 2000

	2008	%
Currently in process of incubation	41	9.7
Start up enterprise associated with chains coordinated by CTTU	57	13.5
Start up enterprise operating independently in agro-export cultivation	60	14.2
Employed in the agro-export sector	30	7.1
Unsuccessful incubation – returned to traditional cultivation	98	23.2
Unsuccessful incubation – moved into non-agricultural employment	39	9.2
Unsuccessful incubation – rural – urban migration	14	3.3
Unsuccessful incubation – due to social reasons (incl health)	28	6.6
Other	9	2.1
Without information	47	11.1
Total	423	100.0

Source: registers CTTU plus interviews with programme managers

Since its re-engineering in 2001 the CTTU has selected more than 420 persons for its enterpreneurship development programme. The table gives an overview of their status in 2008. Of these nearly 10% were in process of incubation in 2008. Fifty seven were engaged in export chains coordinated by CTTU and sixty were doing so independently from CTTU. Another 30 persons could find employment in the same sector, thanks to the competences acquired through CTTU. In almost one hundred instances, CTTU was unsuccesful. Incubatees after some time switched back to traditional cultivation and farming practices. Then there are three categories of what we could characterise as unsuccesful instances as people moved out of agriculture altogether, either they migrated, switched to non-agricultural occupations or social reasons explained their exit. Then there is a significant group of persons (11%) without any information on their whereabouts.
In order to conclude on the performance, table 5 defines ‘success’ and ‘failure’ rates. Criterion 1 is the strictest definition: Have incubatees become independent entrepreneurs who now operate their enterprises in agro-export crops on their own or with independently formed groups? Using this criterion only 14% of the incubatees of CTTU can be considered succesfull. Criterion 2 recognizes that small farm enterprises face systemic market failures and need ‘allies’ who help overcome these. The CTTU performs this role through its coordination of the agricultural production segment of agro-export chains. In this case the success rate rises to 28%. Criterion 3 has the broadest success definition. For people who fail as entrepreneurs but who remain employed within the agro-export chains, one cannot conclude that the investment has been a waste of resources. The investments continue to yield social benefits. In this case the ‘success rate’ of CTTU rises to 35%.
We can also look at the performance of CTTU incubatee looking at the failure side. As shown in Table 5 below, the agregate failure rate is 42%. That is to say, four out of every 10 persons who participated in the CTTU programmes did not form agro-export enterprises or remained active in that sector. However, only 2 out of 10 reverted back to traditional farming practices. The other 2 out of 10 left the agricultural sector completely for various reasons. These causes may be linked to general characteristics of rural processes of change. That is to say they

would have happened irrespective of the CTTU intervention. In that sense they constituted a kind of dead weight factor that needs correction in the evaluation of the CTTU impact. Taking this into account it can be concluded that the overall CTTU performance can be considered positive indeed.

Table 5
Success and failure of the CTTU model

Success	2008	% in 2008
Criterion 1: independent entrepreneur (without any assistance from CTTU)	60	14.2
Criterion 2: independent entrepreneur (with or without assistance from CTTU)	117	27.7
Criterion 3: active in agro-export chains + agricultural employment	147	34.8
Failure	2008	% in 2008
Unsuccessful incubation – return to traditional cultivation	98	23.2
Unsuccessful incubation – other employment (non-agricultural)	39	9.2
Unsuccessful incubation – rural to urban migration	14	3.3
Unsuccessful incubation – social factors	28	6.6
Aggregate rate	179	42.3

Source: table 4

In the next sections I will examine certain aspects of the construction of new institutional arrangements. I will concentrate on the following aspects: i) who is the innovative agent involved and what experiences shaped the rationale of his reflexive actions (section 4)? I will then move on to examine the social construction of institutional choices and their sustainability. Here I will dwell on different actors being networked in a process of experimentation, the factors influencing institutional choices at the level of small producers, and constraints arising from social demands and from hard technologies (section 5); A contextual crisis forces agents to re-examine their institutional choices and adapt these to new conditions. But also internal crises give rise to institutional adaptations. This will be examined in detail in section 6.

4. Innovative agent, background and experiences

The whole process started at the end of the nineteen eighties with the ideas of the Jesuit Priest Jose de Bernardi. He was a child of a Peruvian mother and an Italian father, who migrated to Peru in the post-World War II era. It was a family of entrepreneurs. Initially his father established a construction materials company and later a chemical products factory and also his brothers became entrepreneurs running their own companies from various Latin American countries.

After completing his education, Father de Bernardi was engaged for a number of years in social work in the Andean parts of Peru where he acquired important experiences in working with peasant communities. During the period (1970-1974) he facilitated the organisation of small coffee growers on the borders of the river Marañon into three services cooperatives, so that they could sell their harvests directly to wholesalers, without being subjected to abusive practices of traders. In Jarpa, in the province of Chupaca, Junin in the Sierra of Huancayo he directed an adult education and development centre (PROCAD) in the period 1976-1988) which extended to some thirteen dispersed communities in the Valley of the Cumas River. The Centre became known for its adult education programmes and was very successful in

organising communities in productive activities and in their relations with the state. The Centre succeeded to organise the communities to build an electricity network of a length of more than 30 km so that new production technologies could be introduced and Andean grains could be processed (such as habas, quinua, tarwin, beans, avena). This facilitated considerable productivity increases in agriculture and livestock production, raising people's income and family diet. An important part of these activities were financed by the Dutch catholic co-financing agency (CEBEMO).

Unfortunately, these were also increasingly difficult times. In the nineteen eighties Peru found itself increasingly enmeshed in a political and economic crisis and saw the violent rise of Sendero Luminoso. For a while PROCAD could continue its work in spite of all the rural violence, which led the staff to believe that Sendero would respect the centre for reasons of its considerable legitimacy among the rural communities. Unfortunately that turned out to be an illusion. On the 19th of August 1988 Sendero destroyed the premises of PROCAD and killed its manager and threatened the institution that if it continued it would face the consequences "because although we agree with what has been achieved, now we are at war"[2].

His forced departure permitted the priest to study abroad where he obtained a diploma in rural planning and a master's degree in regional development from the Institute of Social Studies in The Hague, Holland. He developed his knowledge concerning the importance of social organization for the adoption of modern technologies in agriculture and became convinced that small family farming could compete on productivity and quality with large scale farms if and when it gets access to technology, credit and markets all of which requires supportive state policies.

He also studied the social bases of the Sendero movement and was greatly influenced by the work of Peruvian sociologist Denis Chavez on Youth and Terrorism. He came to the conclusion that the leaders of the two principal violent groups (Sendero Luminoso and Tupac Amaru) had obtained education from Peru's regional public universities. For reasons of a lack of sufficient growth of formal employment opportunities and the competition from graduates of Peru's elite universities, these graduates ended up underemployed in informal service activities with low remuneration (taxi drivers, small traders etc). In effect, the inadequate educational policies and the economic and political crisis resulted in a 'lost generation' of young adults who had succeeded to educated themselves with great efforts and who had high expectations for a better life. But frustration and rejection grew and this facilitated recruitment into the guerrilla movements.

Recognising the limitations of the Peruvian labour market led this son of an entrepreneurial family to argue that graduates of the universities have human capital and if they could develop themselves into entrepreneurs, they could generate employment not only for themselves but also for others who had much less human capital thereby contributing to reduce the crisis of unemployment. Furthermore, if studies showed that these professionals who were frustrated because of lack of jobs became leaders of violence, then supporting professionals to create their own enterprises would be a clear way to turn promoters of violence into promoters of peace.

However there were no public or private institutions supporting the formation of entrepreneurs and their enterprises. Incubators did not exist in Peru at that time. The same applied to venture capital activity. Both market and state failed to respond. De Bernardi aimed to fill this institutional gap. But how to select and turn university graduates into entrepreneurs? This became the new challenge for the adult education expert Jose de Bernardi. Learning by doing would be central in his answer. Having defined his target group, three operational questions had to be addressed: i) how to select and convert university graduates into entrepreneurs? ii) What sort of activities would their enterprises be involved in? and, iii) Where could these activities take place?

Upon return to Peru, the priest started to give shape to his ideas. Since Sendero was active in the mountains, he decided to explore possibilities to set up an enterprise development project in the coastal regions of Peru. He travelled from south to north, from Arequipa to Trujillo exploring possibilities and looking for support. He decided to find a location for his project in the proximity of Trujillo. The reason was that there the company was located of Rafael

Quevedo whom had offered him his full support (see below). Father de Bernardi had learned from his studies at the ISS that it could be advantageous for small and medium enterprises (SMEs) to be articulated with large enterprises because the latter can provide access to technology and can provide market and input linkages. Quevedo's company could, in the eyes of de Bernardi, become a kind of 'foster company' for the small enterprises he aimed to incubate. In addition, after having discussed his ideas in the Jesuit Society he obtained financial support from the Jesuit Fund for Apostolic Work[3] and the Bishop of the region gave him the use of a large house in Moche, near Trujillo, where the centre could be set up. That in the end defined the location of the process.

5. Social construction, institutional choices and sustainability

Stimulate creation of enterprises but doing what? With regard to this question, Father de Bernardi considered various alternatives. The first was to produce basic foodstuffs for the domestic market but that option was rejected. Production for the domestic market carries a lot of risks. Small and unpredictable changes in the supply can give occasion to large fluctuations in prices due the lack of efficiency and transparency in trading. That was not a favourable environment in which to launch new enterprises. He also considered the possibility of a small fish processing factory working in association with a large local fishing company.

During one of his journeys in October 1990, Father de Bernardi had a chance encounter with Rafael Quevedo in a small roadside restaurant in Chao district along the Pan-American Highway. Quevedo was born in the region and owned the company TAL S.A. dedicated to the production of chicken feed. Quevedo shared the preoccupations of the Jesuit priest about the unemployment problems in the region and the social and political upheavals of the violence. Quevedo himself was an innovative entrepreneur and had begun experimenting with asparagus production for export on one of the former chicken farms. He had already invested in a processing and packaging plant. In addition, Quevedo had contracted and brought into Peru an Israeli engineer to develop drip irrigation technology. He proposed to De Bernardi an alliance to address the challenges: his engineers and agronomists would help to generate and teach the technology and agricultural practices of asparagus growing to the young entrepreneurs. Rafael Quevedo offered fields at his farm "San Vincente" in Virú where the entrepreneurs could master the technology: install a drip irrigation system and learn to manage it. Quevedo limited himself to a 'foster company' role providing access to technology and know-how and did not make this access to technology conditional to (preferred) buyer of their output for his processing plant[4].

De Bernardi followed the advice of Rafael Quevedo and his technical staff. That is to say to capitalise on the basic resources of the region: soil and climate that would make possible the production of high value horticulture crops such as asparagus with hi-tech agricultural methods[5]. From the perspective of entrepreneurship development and enterprise incubation, asparagus also seemed very attractive. One hectare would be able to generate a significant net income. Moreover, it is a semi-perennial crop that can produces up to nine years with two harvests per annum. Thus, subject to favourable prices it would generate cash flow for a period long enough to permit the new young entrepreneurs to repay the initial loan contracted to finance the start up investments. But to produce asparagus was not without challenges. The quality of the seed is critical and is not locally produced. It would need to be imported from the USA. Although the agronomic conditions of the region seemed very suitable, it would require a lot of experimentation with technology and cultivation practices in order to generate high yields (of high quality). Unfortunately there was at that time no agricultural research institute in Peru specialised in asparagus. The alliance with TAL S.A. was the main source of technology.

Since the climate was dry and without rain, the production of asparagus critically depended on irrigation. Basically there were two technological options: one is water distributed by gravity and drip irrigation with pressurised water. Gravity irrigation demands investment in the preparation of the land and canals and it needs a well for underground water or direct

access to the canal of CHAVIMOCHIC and a water pump to irrigate the fields. The operating costs of this technology are rather high. Gravity irrigation was well-known in Peru. It was developed on the former sugar estates in the region many decades ago. However, at the beginning of the nineteen nineties drip irrigation was not yet known in Peru. Drip irrigation, developed by the Israelis, distributes the water in much smaller doses through a dense network of pipes to each plant. This does not require mayor land preparations but it does need a high investment in the extensive but flexible tube system (US$ 2,500/ha) and pump technology that distributes pressurised water. At the same time it generates less weeds and this saves labour time. Thus, there were important barriers to the development of the necessary know-how to produce asparagus under the local conditions in the area and on a small scale. But the alliance with Tal SA would also give access to the new technology.

In this way the general ideas about entrepreneurship and enterprise development began to transform themselves in concrete plans. Following past practices, the immediate goal was to create a NGO with the aim to form young entrepreneurs and create or incubate their enterprises active in export agriculture. The new NGO had already a basic budget for a nucleus of staff, it had an office and an alliance with a innovative firm to develop the required technology and to which the harvest could be sold. The NGO already had a name: Centre for the Transfer of Technology to University graduates (CTTU). It commenced operations in April 1991[6].

As a true entrepreneur, Father de Bernardi 'used a small fish to catch a large one'. That is to say with the resources that were donated by the Jesuit Fund, a consulting company was hired to undertake a feasibility study which became the basis for an application for support form an international donor agency[7]. This was CEBEMO which had co-financed the PROCAD project and where De Bernardi had prior contacts.

In this section we have seen how background and prior experiences shaped the ideas of the main protagonist to identify the institutional gap as one of a lack of enterpreneurship and enterprise formation. The creation of an NGO and adult education methods were basic reflexes, known to work from past experiences.

Institutional experimentation: trial and error

The process of institutional experimentation is a social process, as it involved various agents, some of whom were known to the innovative protagonist (e.g. Cordaid) and some were new and based on chance encounters (Quevedo and his network). In the process of experimentation, networks of different key agents merge and provide new resources on which the process of experimentation can evolve.

With Quevedo's network the technological innovation was elaborated and adapted, but the further institutional experimentation was primarily undertaken by De Bernardi and new staff of the NGO which he in part recruited from PROCAD as well as from among NGO minded professionals all seeking a career in the burgeoning NGO sector of Peru.

Below we will examine how entrepreneur selection and training became organised and how the NGO experimented to cope with the problems of small size.

Who to select and how to finance?

CTTU did not want to select youngsters with 'proven' entrepreneurial competencies and who thus would be able to present their own business plans. This would supposedly be an excessive requirement which would significantly reduce the number of young graduates who could be converted into entrepreneurs. Moreover this would deviate from the original aim of CTTU namely to form entrepreneurs from among poor young graduates without financial resources[8]. There were no business schools within the public university education system of Peru to cater for entrepreneurship formation. There was also no public funding to enable students to attend private schools. Thus, CTTU had to look for alternative funds and prior experience told CTTU to approach international donors.

With respect to the initial capital to start an enterprise, it was estimated that the cost of preparing the land, the introduction of electrical energy, the buildings and the irrigation system were estimated to reach some 10-12,000 US dollars/hectare. In addition another 2,000

dollars/ha was needed as working capital. It was quite clear from the beginnng that no financial institution would lend money to the CTTU to finance an initial cohort of 25 uni-personal enterprises. The young graduates themselves would not have the required resources to start an enterprise, as they came from poor families. Banks would not even consider business plans of these young individuals themselves as they had no reputation as an entrepreneur and had no financial history. At that time, venture capital institutions did not exist in Peru. And even if they would have existed, they would not consider proposals of young would-be entrepreneurs. There was 'systemic market failure' and this motivated CTTU to include a rotating fund for the initial investments of incubated enterprise in its application to international donors alongside its own operational expenses and the cost of running the entrepreneurship programme[9].

How to cope with small size?

Another key problem in this context was how to deal with the problem of the size of the enterprises to be incubated. From the point of view of economic development, it would be important to maximise the number of entrepreneurs (and enterprises to be created) so as to create a flywheel effect in terms of second order employment which would help reduce the crisis of unemployment. The asparagus feasibility study had shown that one hectare would be able to generate an average net income per hectare of 2500-3000 US dollars[10]. For that reason it was considered the best option to incubate uni-personal enterprises of one hectare only. But this would create however a problem of insufficient scale that manifested itself in various ways. First of all, it showed on the supply side. That is to say, there is a minimum size of the irrigation system for reasons of its fixed costs[11]. According to engineers of TAL S.A. these cost would be prohibitive for one hectare units of production. They estimated that the minimum size would be 25 hectares. There was also a problem on the output side, with respect to the sale of the product. A processing firm would be interested to have one single contract of 25 hectares of asparagus in stead of 25 contracts of one hectare each and in that way reduce transaction costs and coordination problems in the supply chain.

These disadvantages of small size can be overcome by the creation of a cooperative. However, the goal of CTTU was not to create cooperatives but to train young entrepreneurs to start their own independent business. Furthermore, according to Father Bernardi the history of cooperatives in Peru had not been a very successful one and tainted by excessive state interference, by internal political problems, by problems of technical competencies and free-riding by members. Thus, these experiences told CTTU to reject the option to form cooperatives.

Thus, privately owned uni-personal enterprises constituted the basis but its owners had to invest and manage certain assets jointly, such as the irrigation infrastructure and together set up a marketing venture to sell their crops collectively. Collective action in these activities was considered feasible and desirable. This led to the creation of a 'second level' enterprise which in Spanish was called, "Unidad Agroindustrial con Riego Tecnificado", UART. Below we will use the English equivalent term and acronym: Drip Irrigation Production Unit, DIPU

A DIPU operates with one single drip irrigation system on *contiguous* parcels of land. So, in stead of one single cooperative, which would manage all activities with only collective assets, the DIPU had a number of uni-personal enterprises as its base. DIPU was constituted for joint investment in irrigation and joint activities such as marketing. Such collective action implied that graduates not only had to become entrepreneurs, but also had to learn to cooperate with other entrepreneurs.

Entrepreneurship formation and entrepreneur selection

The initial training program of CTTU consisted of three blocks: i) production technology; ii) farm and business management, and iii) business ethics and leadership. The processes of learning in the three blocks followed the seasonal rhythm of agricultural production in the area and had '*learning by doing*' as its basic principle. The knowledge about new production techniques were directly applied on the farm. Each participant would manage his/her own furrow. Those participants who had acquired the technical competences well and and were

able to apply these succesfully, would obtain higher and better quality yields than less successful participants. Business ethics and leadership was directly applied at the Centre itself where participants were housed for short periods of training (the so-called 'internships'). The social interaction of participants with staff and amongst themselves revealed who had leadership qualities and who observed the basic principles of business ethics and who did so to a lesser extent. Thus, in all aspects of the programme participants themselves could observe the performance of everybody else[12]. Effectivelly this would become the basis for a *social* selection of entrepreneurs by the participants themselves.

Institutional choices shaped by technology and by social demands

In order to recruit potential entrepreneurs, CTTU staff moved around in the region, visiting universities, technical and agricultural institutes and also churches in small urban centres and villages. In the cities CTTU tried to raise interest among graduates of technical studies such as industrial engineering, system engineering etc. But also in the rural areas the team found many young people interested, including those who had access to land. Many of them there were sons and daughters of peasant families of the five valleys of the department of La Libertad. Many were children of the so-called 'parceleros' of the Agrarian reform. They had small holdings on former large estates, mostly with irrigation infrastructure. The majority of the Agrarian reform cooperatives in the region did not operate anymore. Many families were unable to optimally exploit their irrigated land for not having the necessary know how and not having the financial capital to exploit it with high value crops. Many of these communities asked the CTTU team to train their children as modern entrepreneurs.

In the end the CTTU decided to respond to this social demand. In its application to CEBEMO it foresaw the creation of groups in each valley to form young farmers with good educational qualifications (graduates from the agricultural institutes) and with access to land (one hectare), with irrigation. In Moche, CTTU would continue to concentrate the young graduates without any access to land and who would have to 'colonise' a plot in the desert.

An important logistical advantage of this decision was that CTTU could start the training programme already while the group without land would still be in the process of acquiring desert plots. Moreover, the pilot schemes in each valley would enable CTTU to recruit new young entrepreneurs from the valleys as candidates for its desert colonisation scheme in Moche.

Many of the trainings and classes were given in the central CTTU office and its farm plot. At this location the engineers and agronomists of TAL S.A. gave their lectures and field instructions about irrigation and asparagus cultivation while the staff of CTTU implemented the training programme in the five pilot areas. The pilot projects would provide feedback which would be incorporated in subsequent rounds of instructions from the engineers.

The Israeli engineer, hired by TAL S.A. discovered that drip irrigation was technically not feasible in the valleys because traditional (open) wells could not generated sufficient pressure for drip irrigation. Tube wells were required. But these were too expensive for dispersed small parcels of land. This meant that in these valleys one could only work with gravity irrigation. Only in Moche, in the desert, there was no other option but drip irrigation. This was a severe and unexpected setback. On top of this, one of the principal advisers of CTTU, Gustavo Guerrero, a senior engineer from Rocio[13], which was another 'foster company', became very concerned about the inefficiencies and costs of operating in a dispersed way in six locations. Small dispersed plots and at a distance from each other raised the cost of transport, distribution and planning of necessary services, the supply of inputs and of the renting and use of machinery. The dispersal of sites would raise the costs of technical field visits, would increase problems to contain plagues and would result in higher harvest and commercialisation costs. According Guerrero it would be much better to select one single well located large site (close to a water source and with road access) that would offer the added advantage of a more controlled environment to develop the technology. For that reason it was decided to to concentrate all activity on the 25 hectare site in Moche near the CTTU offices (which was also close to Trujillo where most experts lived). Already in 1994/5 some

100 young farmers, selected from the five valleys, participated in this way in the programme in Moche.
The move to close down the pilot project in the valleys generated resistance from 'parcelero' communities, led by a former union leader. In the end CTTU responded to their demands and this resulted in a second kind of institutional arrangement, which was denominated "Asociación de Productores Agropecuarios de Riego Tecnificado" (APART) or in English "Gravity Irrigation Producers Association" (GIPA). The important difference with the DIPU was that the DIPU consisted of one set of contiguous parcels and one single centralised drip irrigation system while the GIPA united young farmers with dispersed parcels of land using gravity irrigation. As in the DIPU, each member of the GIPA operated independently, but his learning was jointly organised as a group. While DIPU held and managed core collective assets, GIPA did not. The table in the Annex presents a comparison of farm enterprises under traditional, DIPU and GIPA settings.

6. Crises, opportunities and local adaptations

The end of the decade exposed the vulnerability of an export base that was solely based on one single crop, the asparagus. The origin of the crisis can be found in shifts in the international market (Shimuzu, 2006). In the nineteen sixties this market was dominated by the USA and Europe respectively. These were also the principal consumer markets. However, in the 60s and 70s the production in Taiwan grew rapidly and later also in Mexico and Spain, while the production of the USA and France stagnated. From the beginning of the 80s, the production and export of conserved asparagus by Taiwan decreased as that country went through its industrial transition. Initially the exports of Peru concentrated on conserved asparagus, filling the vacuum created by the withdrawal of Taiwan. However, gradually the production of asparagus in China began to grow, no doubt facilitated by Taiwanese enterprises. Chinese exports grew rapidly in the late 90s when also the Peruvian production and exports expanded spectacularly[14]. In both cases this referred to conserved (white) asparagus. According to interviews with managers of some of the large enterprises in the region[15], China began a true 'price war' which heavily affected Peru. Prices dropped significantly around 2000. It became very difficult for Peru to compete with China on cost price. But there was an alternative, namely the export of fresh green asparagus, notably to the European Union, where the demand for fresh asparagus was growing. China was not involved in the export of fresh asparagus, presumably due to the long distance from the export market. In this market segment Peru had a competitive advantage as it could supply fresh asparagus in the second half of the calendar year while European and Mexican producers, its principal rivals, could only supply asparagus during the first months of the year. Unfortunately the cost of airfreighting fresh asparagus was prohibitive. It was still feasible to airfreight to the USA but too expensive for export to Europe[16]. Thus, the perspectives in the market of fresh asparagus were limited while in the market for conserved asparagus China exerted serious price competition.
A second shock announced itself soon thereafter. Cordaid indicated that its institutional funding to CTTU would come to an end. It had supported CTTU for 10 years and its policy priorities had changed. This posed a serious problem to the organisation. How to secure the (financial) survival of the organisation?
Fortunately also new opportunities emerged. In 1998 the Ministry of Labour had created the National Vocational Training and Employment Promotion Fund (FONDOEMPLEO). This (privately constituted) fund financed projects for training of workers and (micro) entrepreneurs with the aim to generate sustainable opportunities for work and income generation. The Fund was financed from contributions from (formal) enterprises. The annual amounts would be distributed to the departments of Peru on the basis of their origin (except for Lima Callao) and also the Department of La Libertad has its share. The programme called on groups of enterpreneurs and training and service providers to submit proposals for capacity building.

In 2001 the Ministry of Agriculture set up the project Innovation and Competitiveness of Peruvian Agriculture (INCAGRO), financed by the World Bank. This project was aimed at "creating a agricultural system of decentralised and demand oriented technological innovation and led by the private sector with the purpose to raise profitability, increase the competitiveness of the agricultural sector by means of the adoption of sustainable and environmentally safe technologies" (translated from INCAGRO, 2003: 1). Specifically it sought on the one hand to develop the market for innovation services, stimulating and empowering the demand side (agricultural producers), promoting an entrepreneurial orientation towards the provision of quality services and facilitating the matching of supply and demand for these services. On the other hand, the project sought "to develop a plural and competitive system of generation and delivery of strategic services by means of the institutional strengthening and financing of research and development activities, technological transfer, training and information". For the first specific objective an Agricultural Technology Fund was created which would co-finance agricultural extension and adaptive research subprojects. The project called for proposals presented and implemented by strategic alliances between service providers, organised producers as clients of these services as well as other collaborating agencies. The programmes of the two ministries were important for CTTU in the sense that they created a demand for the kind of enterprise development services that CTTU had developed.

Responses to crises and opportunities: technological and institutional innovations

The large agro-export firms developed a response to the competitive threat from China, by investigating how they could expand in the fresh asparagus segment. Innovation in transport of fresh produce was the avenue they pursued. In 2000 the life of fresh asparagus was 15 days. A sea freight journey to Europe however would take 30 days plus 15 days in storage[17]. The technological challenge became how to triplicate the useful life of asparagus so that it can be exported by ship to Europe? The technical solution was found in creating a controlled environment for the product. That is to say, by reducing the percentage of oxygen in the air and adding CO_2 the physiological processes slow down. The plant 'sleeps'. With air controlled containers such a controlled environment could be created. Chile had already succesfully experimented with such technology for its fruit exports to Europe and the container transport company MAERSK offered already a service of such specialised air controlled containers from Chile to Europe and could offer the same serive to Peru. The challenge for Peru was how to investigate and experiment with the controlled environment such that the asparagus reached a useful life of 45 days. This was solved by large companies (notably Campo Sol). Thanks to the upgrading of the seaport of Salaverry, near Trujillo, the new type of containers could be directly loaded onto the specialised container vessels of MAERSK. This saved also the long journey to the port of Lima Callao (520 km to the south).

Nowadays (2007) the export value of fresh asparagus exports of Peru is more than three times the value of the export of conserved asparagus. With this, Peru became the world's largest exporter of fresh asparagus. China still is the principal producer of conserved asparagus and Peru follows in the second place (Source: FAOSTAT). The same technology was later on adapted and extended to other high value export crops.

The asparagus crisis had induced large companies also to look for other high value crop alternatives. The company DANPER investigated the production of artichoke[18]. Based on previous experiences with asparagus DANPER together with CTTU developed the technological and farm management package for small scale production of artichoke. On the basis of previous experiences with asparagus, the technological adaptations came about in a much faster way. Also small producers themselves reacted to the crisis by switching. Some DIPUs independently switched to other agro-export crops such as paprika (DIPU San Jose), 'pimiento piquillo' (DIPU San Juan) or artichoke. Having developed competence in one high value export crop, they could more easily switch to other high value horticulture crops. In the valleys however, GIPA producers switched to traditional crops, such as maize, cotton, onion and pepper or left agriculture altogether.

Responses by CTTU: changing role and mission

In its search for funds to finance new projects to form entrepreneurs, CTTU presented proposals to two ministries, but now with *annual* export crops, such as paprika, artichoke and peppers. The two proposals departed from the same premises: small agricultural producers lack entrepreneurial and technological competences to manage high productive farming and this blocks their successful insertion in export markets[19]. The producers were generally weakly organised for agro-exports, their productivity is low and they have little management capacity. Forming groups would increase their organisation and facilitate the learning process to absorb new technological packages and modern management methods. Under such conditions would they be able to enter agro-export value chains which characterise themselves by a high degree of coordination of production and its quality and of logistics for processing. Both projects defined the target groups as young farmers, between 18-40 years old and with access to a personal land holding of at least one hectare. An alliance with processing companies and buyers of their harvests and with input distributors was integral part of projects that aimed at formation of new agro export chains[20]. The processing company would provide a purchase agreement to all producers that form part of the CTTU project, which sets the price according to specified quality standards and the inputs suppliers agree to sell the inputs on credit on the basis of the sales contract. In other words processing and export firms participated in these projects. This collaborative practice had evolved over the past 10 years.

In this way the CTTU was not only a capacity building institution aimed to form entrepreneurs, but also became an agent coordinating the bottom segment of agro export chains. For the participating processing companies and inputs suppliers, the CTTU became a guarantee for the commitment and quality of the associated producers. Both project applications were approved in 2004[21]. This showed CTTU that the adapted intervention model was viable. CTTU could expand its activities whereby the Government of Peru financed the capacity building and where small producers started paying for field services rendered by CTTU. Thus, by reacting to these new opportunities CTTU defined its future course of action.

These changes led to a new strategic direction by the CTTU team[22]. In the 2004 bi-annual Report presented to Cordaid, the CTTU defined its new role as one of coordination of production chains: “the strategy of production chains on the basis of strategic alliances with processing companies of the region and with input distributors who provide credit without any other guarantee than the signing of an agreement with the moral support of CTTU. This includes the consolidation of farmers as producers and entrepreneurs of export crops such as artichoke, aji, paprika, cotton and asparagus” (Report presented to Cordaid, June-December 2004, p. 4 translation is mine) and: “the strategy incorporates the participation of the following actors: the farmers who commit themselves to seed, cultivate and deliver a quality product to the processing industry which in its turn assures a market at a previously agreed price. The processing firm also provides the seeds. Another important factor is the presence of commercial trading houses that supply inputs on credit to be repaid at the harvest. All together sign a contract committing themselves to the agreements within the production chain. The CTTU operates as a chain operator-articulator and commits itself to coordinate all the other actors” (ibid). The CTTU had a nursery producing seedlings for farmers in the contract schemes. This generated additional income for CTTU as the large processing companies paid for this service and have contributed to finance and implement the nursery[23].

In 2004 the CTTU expanded the new scheme of contract farming: groups of small producers were formed in GIPAs around the contracts coordinated by CTTU; In 2004 two GIPAs produced produced artichoke. The new GIPAs were formed with members of old GIPAs that existed in Chao and Virú. In 2005 and 2006 the model expanded rapidly. The multiple contracts with two companies diversified in four crops (artichoke, small peppers, sweet peppers and Italian squash).

What did the role of chain coordinator consist of? For the processing and exporting companies and for the distributors of input on credit, the CTTU functioned as a quality guarantee and assurance of supplying the agreed quantities specified in the contracts. By acting as a chain coordinator CTTU reduces the diseconomies of small scale of the individual producers and reduces the transaction costs for large firms. Its entrepreneurship development programme and the technical assistance in the field during the whole production season and the harvesting assure the high productivity and quality. Moreover, the coordination by CTTU during the entire campaign reduces the risk of 'side selling' by individual producers and reduces problems of repayment of the obtained credit. The chain coordination in terms of logistics during planting and during harvests adds further value for the companies as well as for the small producers. The first pay for this partially and implicitly by channelling the supply of seed through the nursery services of CTTU[24] and the small producers pay a service fee per hectare for the business services rendered by CTTU.

In order to reduce the economic risks of operating in the market, CTTU formalised the GIPA institutional arrangement, specifying rules and regulations, rights and duties of the members and more recently manages a system of farmer bank accounts, of which CTTU and the producer are co-signatories.

This redefinition of its role in relation to smallholders and firms in the export chains cannot be seen independently from the crisis of survival of CTTU itself, brought about by the announcement of the donor agency that it wuld end its financial support. A redefinition of roles and organisational survival had to compatible. The CTTU senior management was exposed to conflicting views. On the one hand there was NGO pressure, which included the donor agency which emphasised the developmental and political role of CTTU. This view was expressed by NEXOS, a non-profit advisory agency contracted to advise on future directions. A contrasting view was the business perspective, expressed by the consulting company Recursos S.A. which was hired to examine the business potential of CTTU business services.

NEXOS saw the mission of CTTU to develop entrepreneurial capacities: The entrepreneurship development programme unit captured the vision as well as the expectations of the population about the role of CTTU[25]. With regard to the Business Services unit NEXOS was of the opinion that it should be externalised. It would not be viable to have this unit under the NGO itself. In order to generate resources it is not necessary to have a specific programme, according to NEXOS, since "that is a general task of the institution". NEXOS went further and argued that CTTU should have an assembly of associates as the superior body that ultimately would define the overall policy direction of CTTU. Thus CTTU would have to transform itself from an intermediate organisation into a membership organisation.

The position of the Business Services Centre was the most complicated one: according to NEXOS and Cordaid it should be externalised in order to function optimally. For the staff of CTTU, the Business Service unit was an important measure to assure organisational continuity. Externalising it would aggravate the problem of financial institutional continuity even more. The staff of CTTU, in a rather pragmatic way, was trying to maintain its civic orientation and adapt to the new economic realities. It wanted to shift from a subsidy dependent non-government organisation to become a non-profit organisation based on user fees. The business plan developed by RECURSOS S.A. supported the feasibility of this shift.

Mismatches and adaptations

In the pre-crisis years the DIPU entrepreneurs made substantial profits. These were invested in two ways. Many entrepreneurs invested their surplus in non-agricultural ventures (urban properties and non-farm enterprises). Since the uni-personal enterprises were small (1 hectare) the management of these enterprises was not full time occupation for their owners. Hence they could easily diversify their portfolio and with that reduced their presence at the DIPUs. Other groups of entrepreneurs jointly acquired landholdings in the valleys to expand agricultural production.

Already in 1999, 10 of the 12 members of the DIPU San Juan in Moche (created in 1993), formed an agricultural company ("Agro San Juan SAC") and with the profits made they

acquired 75 has of land in Virú to exploit these as one agricultural unit[26]. In 2001, 8 of the 10 members of the DIPU San Martin in Moche (created in 1996) together formed an agricultural company, called "Monteverde SAC" which acquired 30 hectares of land in Chao to be run as one agricultural unit. In 2003, 4 of the 12 original members of the AUDI San Jose in Paijan (created in 1998) together with 2 outside persons formed the company "Agro Líder SAP SAC" and with the profits of the initial years, they acquired a new farm of 25 hectares. The four partners each had a different function in the new enterprise[27].

Why did they form new agricultural enterprises? There were two reasons. One is that a DIPU is a *civil association* and as such had indivisible unitary assets and hence could not distribute profits. An enterprise level consolidation would not be feasible. Secondly, in so far as one would look for enterprise development beyond the initial uni-personal enterprise of one hectare, there would be no alternative other than to legally constitute an enterprise as an economic unit in stead of transacting through the civic association. Under Peruvian law the best option is the legal figure of a limited company which can be legally represented, sign contracts and distribute profits. Economic risks would be limited to the assets of the company and the entry of new and exit of old partners would be possible by buying and selling shares of the company. A second reason has to do with such entry and exit of members. Since the DIPU is a non-profit voluntary association any member, who wishes to leave, cannot demand any compensation and cannot withdraw any capital. The experiences with the DIPUs show that this issue was an important source of conflicts[28]. With the creation of limited share companies the entrepreneurs became independent of CTTU and engaged in independent enterprise development but in a way different than originally foreseen.

The DIPU proved to be an institutional arrangement unsuitable for enterprise consolidation as well as for enterprise incubation beyond its original physical domain. Selected members of DIPUs responded by creating agricultural enterprises to overcome the DIPU's limitations.

7. Concluding remarks on the co-evolution of technical and institutional change

The process of institutional construction begins with the realisation that there exists an institutional gap. In our case the lack of institutions that would train potential entrepreneurs and enable them to incubate modern enterprises was identified as the key institutional gap. Smallholder inclusion as modern farm enterprises in agro-export chains would not have been possible without introducing smallholders to farming competencies and irrigation technology and without the complementary institutional arrangements created by local social agents. Ways and means had to be found to select entrepreneurs, introduce them to the new technologies and institutions to overcome the problems of small size and to link them to other firms in agro-export chains. The institutional choices were heavily influenced by past succesful experiences of adult education in rural development as well as by the formative background of the innovating agents.

The process of construction of the institutional arrangements is a social process involving multiple agents. The novelty of the CTTU approach is found in the association of the NGO with a business firm something which in those days in Latin America was far from common as well as in the approach to learning and in the institutional choices made by the innovating agent.

Conventional approaches to enterprise incubation, namely heavy selection at the gate were not feasible. Moreover these practices were not known at that time in Peru. Entrepreneur selection became integral part of capacity building in which 'learning by doing' demonstrated to participants who of them possesed the required qualities.

The process of social construction was one of trial and error. Certain choices that were made at the start of the process, had to be overhauled after a serious crisis had shown existing arrangements not to be robust enough to cope with the considerable risks of mono crop agro-exports. The accumulation of debts of smallholders almost led to the collapse of the CTTU. At least one large firm went bankrupt. The process of trial and error is to some extent blind as all ins and outs cannot be anticipated. The originally favoured option (DIPUs) was

discontinued. The GIPA arrangements created in response to community demands and considered ‘second best’ turned out to be the most durable one.

The process of reconstruction and recovery after the crisis in asparagus was possible thanks to the fact that the region had acquired a certain ‘critical mass’ in agro-export related firms: agro-firms, input suppliers, processors, logistics etc. This ‘critical mass’ enabled technological innovation. In addition it gave the region political clout to obtain infrastructural improvements from the central government and played a role in an agricultural policy more favourable to agro-export.

It is well known that technological innovation comes in small steps. This is evidenced by the innovations in the transport of fresh produce. The firms in the region benefitted from the very fact that Chile had practiced the air controleed containr technology before and that Maersk had already initiated a shipping line with such containers to Europe.

Also the institutional construction process turned out to be incremental. New institutional arrangements were heavily influenced by past succesful practices of community development. The institutional arrangements developed in the early stage could be formalised and adapted to other crops later on, after CTTU as well as smallholders had acquired a reputation for quality production. Firms agreed to engage smallholders in contract farming and banks agreed to provide loans to smallholders on the basis of only the (tri-partite) contracts and without any collateral something which was unheard of a decade earlier.

The process of trial and error led to adaptations in these arrangements as in the case of the GIPAs. The rules and regulations were made explicit and flexible, defined in function of new contracts. The ‘fitness’ criterion (Nelson, 2005) helps to determine the evolutionary path of a new institutional arrangement. The institutional arrangement of the DIPU, although effective to build collective assets, did not ‘fit’ the requirements of enterprise incubation beyond the uni-personal enterprise of one hectare and it could not serve as a vehicle for enterprise consolidation of all uni-personal enterprise into one single enterprise with specialised managers. Entry and exit and collective action problems were the principal causes. Entrepreneurs responded by shifting emphasis to other institutional forms (namely Sociedad Agricola Cerrada). The DIPU arrangement was effectively discarded.

From the above we can conclude that the model of social construction proposed by Gomez (2008) and set out in section 2 is a relevant and valid. An institutional gap was identified, the construction of new institutional arrangements goes in parallel and interacts with technological change. Multiple agents are involved. The process of trail and error is heavily influence by situated bounded rationality of the agents (Hodgson, 2003). Sustainability of the institutional arrangements could not be examined in detail but the acceptance of the smallholder contract farming arrangements by other chain agents is in itself proof of sustainability.

Annex

Comparison of enterprise features under DIPU, GIPA and traditional small farmer settings

Concept	**Traditional**	**DIPU**	**GIPA**
Population	Farmers	Youth, with tertiary education, without land	Youth with secondary education, with land
Type of terrain	Agrícultural land	Virgen land	Agricultural land
Agricultural unit	Dispersed	Form an unified whole	Same neighbourhood
Size of holding	Variable	One hectare per peron	One hectare per person
Organisation (size)		Association, 8-12 unipersonal enterprises	Association, 10-25 unipersonal enterprises
CTTU services		Training, technical assistence, credit	Training, technical assistence, credit
Cost of installation	US$ 800/ha	US$ 12,000/ha for asparagus	US$ 4,500/ha for asparagus
Irrigation system	Gravity	Drip irrigation	Gravity irrigation
Comercialisation	Farm gate	Quality standard and invoicing to factory	Quality standard and invoicing to factory
Credit	Without credit	95% with credit	Initially, 50%, currently: 30%

DIPU (Agricultural Unit with Drip Irrigation); GIPA (Association of Agricultural Producers with Irrigation).
Source: Presentation of CTTU, December 2004 and Wils & Benavides 2001, p. 22

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Interview with Jose de Bernardi sj in 2006 and 2008; producers, (7) members of the GIPAs in Chao in 2006 and 12 members in the same district in 2008; (7) members of DIPUs of San Juan (Moche) and San Jose (Paijan) in 2006 and meeting with DIPU members in Paijan in 2008; staff of CTTU, among them: Florentino Jimenez (2006), Jorge Quintero (2006 and 2008); as well as Rafael Quevedo (2006), Gustavo Guerrero (2006) , Ramon Ponce (2006 and 2008) and Frits Wils.
Statistical sources: FAO, Government of Perú, Archive CTTU, Archive Cordaid

Endnotes

[1] A routine involves a collection of procedures which taken together result in a predictable and specifiable outcome.
[2] Personal communication Jose de Bernardi sj.
[3] The initial grant was equivalent to 50,000 us dollars
[4] TAL S.A. participated in the auctions organised by the young entrepreneurs but only on rare opportunities and in small amounts did they take advantage of his offers.
[5] The climate of Northern Peru is rather favourable because it is stable and has small variations in temperatures (18.4-22.3 C). This would make possible two asparagus harvests per annum. Moreover, thanks to the stability of the climate it would be possible to choose the desired period of harvesting in function of sales and export demand opportunities. That flexibility constituted an important competitive advantage: Peru would be able to find the most favourable market niches and define accordingly in what period of the year harvesting should take placeBased on the text: how to produce asparagus (www.monografias.com/trabajos29/produccion-esparragos/produccion-esparragos.shtml - 49k), downloaded on 17/09/2007
[6] CTTU was formally registered as a non-profit cultural and social association (Asociación cultural y social sin fin de lucro) on 15/07/1994.
[7] This study was undertaken by Ramon Ponce, director owner of the consulting firm Recursos S.A. who from that moment onwards has become an important advisor of CTTU and who is member of the Governing Board of CTTU since its foundation.
[8] The criteria to qualify as a participant of the program were: 1. Subscribe to the institutional mission of CTTU, 2. Professional abilities; 3. Ability to work in teams; 4. Accepted by the community in which the project takes place; 5. Willingness to take on credit and contribute own savings, and a general problem solving attitude; 6. Willingness to share achievements with others.
[9] The CEBEMO grant included 124,000 US dollars for a rotating fund to finance the investments for asparagus production.
[10] Feasibility study Recursos S.A.
[11] These are the costs of leveling the land and preparation of the soil, access to water, pump for pressurized water, piping and supply of inputs.
[12] This practice was important so that groups would distribute tasks in accordance with the respective qualities of everyone, increasing in that way the group level efficiency. Due to that process the women in the group were at the start of the programme often seen by the men as a certain burden for the group because they did not have the same physical strength. But as in this phase of practicing farming human qualities and responsibility became more important such as care of assets, organisation and attention to detail, women started to gain prestige and that often led to groups assigning women positions of responsibility that helped raise productive efficiency and product quality.
[13] Later on he became the General Manger of the company Campo Sol S.A.
[14] In 2004 China accounted for 44.1% of world asparagus production (Shimuzu, 2006)
[15] Interview with Rafael Quevedo, General Manager of TAL SA; interview with Gustavo Guerrero, General manager of Campo Sol. June, 2006. See also Shimuzu (2006)
[16] According to Gustavo Guerrero airfreight charge in those days was 2,30 us$/kg (interview, June 2006)
[17] This analysis is drawn from an interview with Gustavo Guerrero, Trujillo, Junio 2006.
[18] DANPER in contrast to other companies in La Libertad did not follow a strategy of vertical integration (production, processing and export) with limited outsourcing from smallholders, but specialised on processing and export and relied more than other companies on sourcing their inputs from other companies, including smallholders.
[19] Insert reference to the 2 proposals (INCAGRO and FONDOEMPLEO)
[20] The project documents incorporated formal written contracts with processing companies and input distributors.
[21] The project financed by INCAGRO involved 63 producers with a total of 112 has of artichoke. They obtained an average profit of 1092 US dollar/ha and an average 1941 dollar per producer. Profitability with respect to costs was 33%. (Source: Power Point Presentation for the closure workshop; CTTU, abril 2005, “Apoyo para el fortalecimiento de cadenas comerciales en cultivos de agroexportación en los Valles de Chao, Viru,y Moche en el Departamento de La Libertad”).
[22] Later on similar projects were presented to the Spanish NGO Manos Unidas and to PRODELICA-Minera Barrick, both in 2005. The first one, located in the Departamento of Ancash, was approved and implemented by CTTU.
[23] Bi-annual report to Cordaid, June –December, 2004, p 4/5

[24] At the San Jose land holding CTTU runs the nursery to produce the seedlings. The seeds are obtained for large companies at a credit. CTTU sells these seedlings to the small producers, something which generated some net resources for CTTU. In 2003 the net returns of asparagus, seedlings and humus produced were US$ 3,461 (source: Informe Memoria a la Junta del CTTU, 2003).
[25] Informe Narrativo to Cordaid, 2002
[26] Source: Annex of the CTTU proposal to Manos Unidas, 2005
[27] Source: field interviews with members and Florentino Jimenez in June 2006 in Paijan
[28] In the DIPUs in Paijan such conflicts took place (Source: interview with members in June 2006) but it is known that this also happened in the DIPUs in Moche (Source: interview with Father de Bernardi, June 2006). The conflicts in Paijan are compounded by the fact that land ceeded by the community if land under communal tenure and cannot be privately sold to DIPU members.