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## SGA Newcomer Award 2016

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### 1. Rang

#### **Design and implications of a tradable certificates system for cropland protection in Switzerland**

Marc Chautems (ETH Zürich – Bachelor Thesis)

*The sectoral plan for cropland protection of 1992 is currently being revised. Tradable certificates could represent an interesting alternative to the actual legislation. This Bachelor Thesis explore the design and implications of a tradable certificates system for cropland protection.*

*The idea is that an owner that want to overbuild a piece of cropland need to own a certificate. The certificates can freely be traded and the market set the price. A model simulation show that for a reduction of 5% of the cropland use, the market equilibrium certificates price would be around 60 CHF/m<sup>2</sup> and rise to 120 CHF/m<sup>2</sup> in around 20 year. This progressively increasing certificates price should ensure a smooth transition to less cropland use. Further, the model shows that the certificates system should not systematically disadvantage a specific region or canton.*

*In conclusion, tradable certificates seem to represent a serious alternative to the actual sectoral plan; they could provide a more flexible and efficient solution.*

## **Introduction**

The sectoral plan for cropland protection of 1992 protects a minimal surface of 438'560 ha cropland in Switzerland (ARE and BLW, 1992). The goal of this measure is primarily to ensure sufficient sources of food supply to the country in case of crisis situation (ARE and BLW, 1992). Nevertheless, this plan also have other targets, such as the quantitative soil protection, the long term conservation of good agricultural land, etc. (ARE and BLW, 1992). To guarantee this conservation target, the minimal cropland surface has been split between the 26 Swiss cantons. Each canton is responsible to preserve its own quota of cropland.

During the last years, more and more cantons reached their quota and started to claim for a more flexible regulation. The sectoral plan is currently being revised and during the year 2017, different experts groups should develop an «up-to-date» sectoral plan for cropland protection («eines zeitgemässen Sachplan FFF (ARE and Lezzi, 2015)»). In this context and in regards with the increasing pressure on the actual system, it is reasonable to question if a more flexible system, such as tradable certificates would be a possible alternative to the actual sectoral plan for cropland protection.

## **Research question**

The first question to answer is how a tradable certificates system for cropland protection should be designed to replace the sectoral plan for cropland protection in an appropriate way and to be as efficient as possible.

The second question is then to investigate what the implication of such a tradable certificate system would be; how high would the equilibrium certificates price be? And how does it evolve over time? How does it affect the different regions (urban vs rural)?

## **Theoretical foundations**

In the case of the overbuilding of cropland, we are faced to an externality problem. It is often profitable to overbuild a piece of cropland from a private point of view, but not from a social point of view. The two main

possibilities to deal with an externality problem are so called «command and control» instruments, versus so called «market based» instruments (taxes or certificates). Market based instruments are more efficient than command and control instruments if we ignore the role of transaction costs (Perman, 2011). In theory, taxes and certificates lead to the same results, but in practice, under uncertainty, certificates are more appropriate to reach a quantitative target. For this reason, certificates are probably better than taxes to replace the sectoral plan for cropland protection (which consists in a quantitative target).

Several studies have been done about controlling overbuilding with tradable certificates in Switzerland, but they all focus on controlling building land in general and not specifically on cropland (Gmünder, 2004; Pro Natura, 2005; Süess and Gmünder, 2005; Zollinger and Seidl, 2005; Zollinger, 2006; Schlapfer, 2007; Menghini et al., 2015a).

Their general conclusion is that tradable certificates cannot replace the traditional zoning instruments, but that they are especially efficient for the control of quantitative land use, and this is exactly what we need in the context of the sectoral plan for cropland protection.

Many different types of tradable certificates systems exist, but for all of them, we are faced to a trade-off between increasing transaction costs and decreasing control of location and impact of the pollutant (Walz, 2006; Henger and Bizer, 2010; Tietenberg, 2010). In the case of cropland protection, the control of the location and impact of overbuilding is already ensured by the «classical» spatial planning instrument (zoning). Thanks to this, we can choose the tradable certificates system with the lowest transaction cost, namely undifferentiated certificates. There are many other choices to make for the design of tradable certificates, but in summary we think that private actors trading with undifferentiated certificates and grandfathering as an initial allocation are the best options. The principle is that a certificate allows its owner to overbuilt one square meter of building zone situated on cropland. Note that the certificates do not give the

right to its owner to overbuild any cropland; the piece of cropland to overbuild need to be situated inside the building zone. By doing so the spatial planning authorities can keep the location of overbuilding under control.

### **Methods**

The overall goal is to develop a method that allows us to estimate the implications of a tradable certificates system for Switzerland.

In a first step, we try to estimate the forecasted cropland use in each municipality. To do this, we combine several geodata layer in order to estimate the building land reserves, and which proportion of these reserves are located on cropland. The combination of different geodata layers produces the map presented in Figure 1. We then assume a linear population growth (based on the last 5 years) and combine these two pieces of information to estimate the forecasted cropland use without certificates.

In a second step we define a reduction goal; how much do we want to reduce the cropland use against the actual trend.

By using this reduction goal, we can, in a third step, calculate the corresponding equilibrium price for the certificates. To reach this, we use a model similar to the one used by ARE (2006) and extended it in order to account for the fact that the building land supply can be covered by building land on cropland versus building land not on cropland. The idea of the model is that the price of building land will be affected by the introduction of certificates. This would lead to a demand decrease. In order to find the equilibrium certificates price, we then need to sum the reduction in cropland use in each municipality and equal it with the overall reduction goal.

Once we found the certificate price, we can use this price to calculate the effects of the introduction of tradable certificates for cropland protection on different indicators (such as the building land price increase, the building land use reduction, the number of certificates traded, etc.).

Figure 1: Extract of the results of the calculation with the geodata. Red zones represent unbuilt building zone, light orange zones overbuilt building zone. Dark green zones represent fields that are part of the protected cropland, light green zones represent fields that are not part of the protected cropland. Dashed zones are intersection between field and building zone (fields inside the building zone). Dashed dark green zones (cropland within the building zone) are the object of the tradable certificates system. This map has been produced for all Switzerland.



## Results

Figure 2 shows where the reduction of cropland use would mainly occur. Similar maps for different indicators can be found in the complete version of the bachelor thesis (increase in building land price in each municipality, certificates balance, etc.).

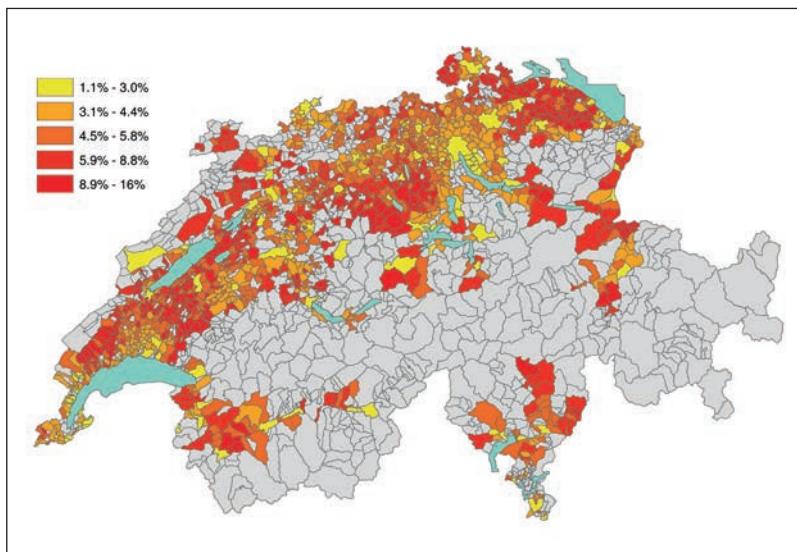


Figure 2: Reduction of the building land use on cropland caused by the implementation of tradable certificates (percentage). The colour scale represents the extent of the cropland use reduction from yellow (= less reduction) to dark red (= high reduction). The maximal building land use reduction is 16.3% and the mean 3.5%. Results for an overall reduction goal of 5%.

An important point is also to be sure that a tradable certificates system would not impact some regions stronger than other; Figure 3 shows that the effects are generally quite homogenous between the different municipalities types; urban and rural areas should be more or less equally affected.

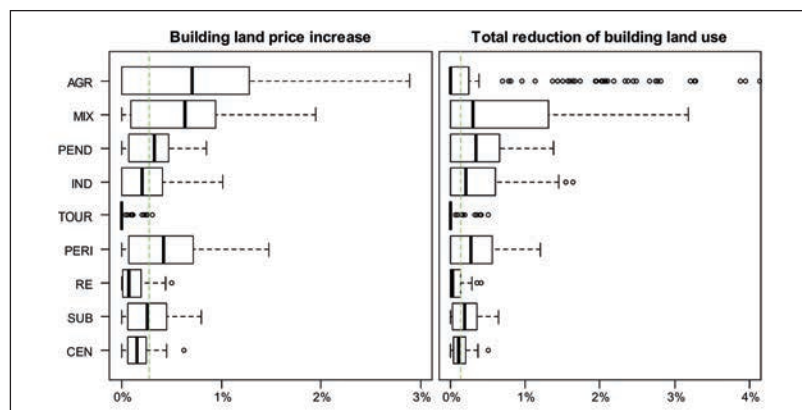


Figure 3: Distribution of different indicators within the respective typology (9 categories; BFS Gemeindetypen 2000) of the municipalities (boxplots). The green dashed line represents the overall median. Results for an overall reduction goal of 5%.

(AGR = Agrarische Gemeinden, MIX = Agrar-gemischte Gemeinden, PEND = Ländliche Pendlergemeinden, IND = Industrielle und tertiäre Gemeinden, TOUR = Touristische Gemeinden, PERI = Periurbane Gemeinden, RE = Einkommensstarke Gemeinden, SUB = Suburbane Gemeinden, CEN = Zentren)

If we look at the evolution of the certificates price over time, we see that the certificate price increase exponentially, but slowly. For example, for a reduction of 10% of the building land use, the certificates price starts at 120 CHF/m<sup>2</sup> and progressively rises to 250 CHF/m<sup>2</sup> after 20 years. The price rise because after a certain time the alternative sources of building land start to be scarce.

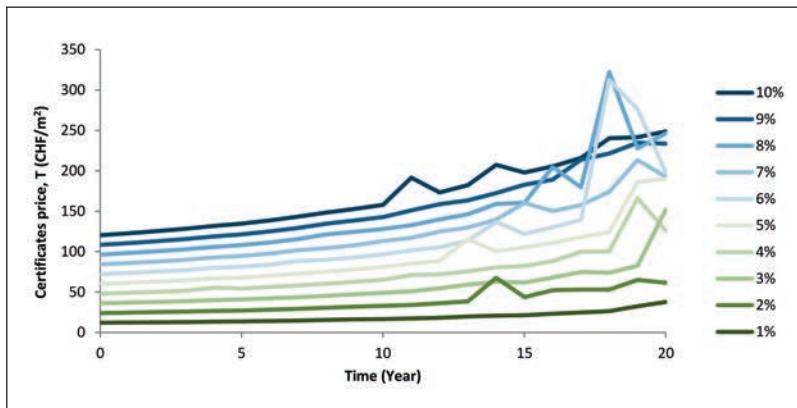


Figure 4: Evolution of the certificates price over time with different restriction severities.

A sensitivity analysis of the elasticity of the demand and supply shows that the elasticity of the supply is more important than the demand. So, the certificates price will mainly depend from the reaction of the suppliers and less from the reaction of the demanders.

### Discussion and conclusion

The results of the simulation model are realistic and in line with other studies on the same topic (ARE (2006) and Menghini et al. (2015b) simulate the effects of certificates for building land in general). Moreover, most of the results do not depend of the absolute high of the certificates price and the dynamic that this Bachelor Thesis underlies would be the same with a different certificates price. Namely we observe that the percentage reduction of cropland use is always higher than the percentage building land price increase. This is due to the fact that with certificates actors can use alternative sources of building land (building land not on cropland) in order to save certificates costs.



Even if the topics of transaction costs and the political acceptance should be further researched, tradable certificates have several advantages over the actual legislation. They are more flexible and more efficient. Further, the certificates price is not too high and the progressive increase should ensure a smooth transition to less cropland use. Also, tradable certificates are fair; no canton is systematically disadvantaged. Finally, tradable certificates give an incentive to use alternative sources of building land (building land not on cropland), unlike the actual legislation.

All in all, it seems that the sectoral plan for cropland protection is the perfect object to be replaced by certificates. As several studies highlight, certificates cannot replace the traditional zoning instruments, but are especially suitable for supplement them when it goes to the quantitative control of land use, and this is exactly what the sectoral plan for cropland protection represents.

To conclude, we can say that the tradable certificates are a serious potential alternative to the actual sectoral plan for cropland protection.

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## 2. Rang

### **Auswirkungen von Investitionen und Finanzierungen neuer Milchviehställe im Schweizer Mittelland unter Berücksichtigung von Investitionsförderungen**

Janic Bucheli (ETH Zürich – Bachelor Thesis)

*Investitionen in neue Milchviehställe im Schweizer Mittelland weisen einen hohen Finanzbedarf auf und belasten die Liquidität der Betriebe langfristig. Deshalb unterstützt der Bund und vereinzelt Kantone landwirtschaftliches Bauen mit Krediten und Subventionen. Die Investitionen haben nicht nur inner- sondern auch ausserbetriebliche Auswirkungen. Daher ist eine gesamteinheitliche Betrachtung für eine Evaluation der Förderungsmaßnahmen notwendig.*

*In dieser Bachelorarbeit wurden Auswirkungen der Investitionen mit Hilfe von Daten aus den Gesuchanträge für Investitionskredite und kantonaler Subventionen aus den Kantonen Thurgau und Zürich untersucht.*

*Im Zuge der Investitionen nehmen die Verschuldung und das finanzielle Risiko zu. Das Vorhandensein von kantonalen Subventionen führt nicht signifikant zu einer anderen Finanzierungsform und auch nicht zu höheren Baukosten. Der Tierbestand wird erhöht und die Spezialisierung auf Milchproduktion nimmt zu.*

*Investitionsförderungen scheinen nicht strukturstabilisierend zu wirken. Kantonale Subventionen scheinen keine negativen Auswirkungen zu haben, sind jedoch wahrscheinlich von geringer Effizienz.*

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### 3. Rang

## **Assessing the Sustainability of Typical Tea Production Systems in India by Applying the Sustainability Monitoring and Assessment Routine (SMART) Based on the FAO's SAFA Guidelines**

Nicolas Hofer (ETH Zürich – Master Thesis)

*In this thesis three typical tea production systems of three distinct tea regions in India were defined and assessed on their sustainability performance. This was done by applying the Sustainability Monitoring and Assessment Routine (SMART) based on the FAO's SAFA guidelines. Focusing on typical production systems allows one to make inferences to a broader group of farms, while the obtained results are on farm level, which is one of the most important lever for moving towards more sustainable food systems. The typical production systems were defined and evaluated by experts and literature consultation. The obtained results show, that SMART is very well applicable to tea production systems. The obtained SMART results also show, that the sustainability performance of the selected production systems are overall rather modest, especially for the environmental and economical dimension of sustainability. The typical tea estate from Darjeeling often has the highest goal achievement in regard to the SAFA sub-themes, followed by the Assamese estate and the STG from Nilgiri. The results further indicate, that the current, fast growth in small tea growers might have a negative impact on the overall sustainability performance of the Indian tea sector. The importance of institutionalized assistance to small tea growers is therefore emphasized.*

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