Collaboration for Environmental Evidence

Systematic Review No. 67

WORKING TITLE

DOES TOBACCO CULTIVATION (GROWING, CURING) DISRUPT ECOSYSTEM SERVICES IN A UNIQUE MANNER?

Draft Review Protocol

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Cover Sheet

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1. Background

Cultivated in 128 producer countries, tobacco of the commercial smoking product species *N. tabacum* (Solanaceae [26775]), a transgenic, labour-intensive crop and legal drug, is the world's most widely grown non-food crop (c.f. tomatoes in 162 countries, maize 154, cabbage 135, wheat 125). Almost all land under tobacco, i.e. 90% of 3.9 mill. ha globally (FAO, 2008), is located in semi-arid to subhumid (sub)tropical areas of low- and middle-income countries. Local- to national-scale studies demonstrate the prominent importance and ecological significance of rapid land-cover change in (sub)tropical dry ecosystems, i.e. from forests and woodlands to cultivated systems (Janzen, 1988), but these changes remain still poorly documented globally (Lambin et al., 2003), and with particular regard to tobacco (Heilig, 1994).

Triggered by the public health debate about smoking, it has been revealed that tobacco poses a particularly difficult environment-development dilemma (WHO, 2003, 2004; Ramin, 2006). In particular, land use interventions such as high-intensity farming (to increase yields and thus nicotine content in green leaves) and the usage of wood in curing (to dry green leaf) have been identified as environmental pressures which potentially disrupt the constituents of human well-being in rural areas where the crop is grown. Disruptions may include, among others, soil/water degradation (nutrient extraction, erosion, land/water pollution), vegetation/biodiversity losses (forest/woodland degradation, deforestation), and human diseases (pesticide poisoning, green tobacco sickness) (Ponting, 1991; Lightwood et al., 2000; Clay, 2004).

A crop-specific global convention, the International Framework Convention on Tobacco Control (FCTC), has been put into practice in 2005 to address, among others, the socio-ecological losses of tobacco farming (article 18), and to require parties to the convention to explore sustainable (non)agricultural alternatives (article 17) (WHO, 2005). Due to its addictive properties and high costs to society, the use of tobacco is a "unique case" (Keyser, 2007, 5), and claims have been made that this applies to the production of tobacco as well, especially with a view upon externalities caused by artificially cured Virginia (flue-cured) tobacco as most widely grown crop variety (WHO, 2007, 2008a).

An international study/working group has been established, "considering that the pursuit of alternative livelihoods to tobacco growing should be addressed with a long term sustainable approach and from a development perspective, as it involves health, social, environmental and economic aspects beyong substitution of one economic activity for another" (WHO, 2008b, 45). The group has synthesiszed the current and potentially unique features/trends of the human-environmental condition related to tobacco farming (WHO, 2008a, 3-5):

- Tobacco depletes soil nutrients at a much fast rate than most crops, exacerbated by specific land use practices such as topping and desuckering which are human interventions to raise, among others, the content of nicotine in green leaves ("the tobacco seed contains no nicotine"), thus triggering a "massive outflow of nutrients" from the soil.
- Forest degradation, deforestation due to curing, and deforestation due to clearance for more land (also compensating lost nutrient levels), are three

major types of vegetation change associated with biodiversity losses; tobacco farming "may be up to 10 times more aggressive than the sum of all other factors in deforestation"; the global share of agricultural land used for tobacco is less than 1%, but its impact on global deforestatoin is 2-4%, "making a visible footprint for climate change".

- Various occupational risks exist (pesticide intoxication, respiratory and dermatological disorders, and cancers at certain sites), but green tobacco sickness (GTS) is seen as "the disease most specifically related to tobacco growing" (resulting from dermal absorption of nicotine), with the use of personal equipment restricted by the pursuit of low production costs, among others; women and children are most vulnerable because they are often employed due to the labour intensive nature of the crop.

In sum, "the group acknowledged that tobacco growing causes biodiversity losses, land pollution due to pesticides, soil degradation and deforestation, as well as water pollution" (WHO, 2008a, 5). It concluded that related costs of tobacco farming such as "health risks, working conditions, contractual arrangments, … and the environmental practices … have negative impacts on human capital and land, the two crucial assets in rural livelihoods", and that the mitigation of socio-ecological losses is "borne almost exclusively by farmers, dspite the fact that the cause of ecosystem disruption … is the engineering of tobacco to deliver nicotine" (WHO, 2008a, 4). The group has been mandated to standardize terminology, methods, instruments, and variables as well as elaborate policy options and reccommendations for the implementation of FCTC articles 17 and 18 (WHO, 2008b, 45),

The tobacco industry (cigarette manufacturers, leaf trading companies) as well as related agricultural lobby organizations continue to refute human-environmental arguments (CETID, 2000) on the basis of poor scientific evidence, among others. For example, the International Tobacco Growers' Association (ITGA) states that "in developing countries (…) tobacco growing can (…) contribute to the sustainable development of the region (..), because, among others, tobacco is "less harsh on the environment than many other crops" (ITGA, 2007). These and other controversial arguments related to tobacco as an environment-development issue (Table 1) have slowed the implementation of supply-side tobacco control measures in the period preceding the FCTC. Only at the turn of the millennium, transnational tobacco corporations in strategic partnership with groups such as DEFRA, English Nature, Earthwatch Institute, Fauna & Flora International, and Tropical Biology Association have started to address issues of environmental management. For example, issues of wood consumption in curing and related biodiversity impacts as well as crop management and related pesticide exposure have been addressed in corporate social responsibility (CSR) projects (BAT, 2008). Differently, the mitigation of a potentially unique occupational health hazard such as green tobacco sickness (Arcury and Quandt, 2006; Schmitt et al., 2007) has not yet become a science-policy concern. The existence of GTS in tobacco growing areas is not acknowledged, and it is thus not recognised as an occupational disease (WHO, 2007, 2008a). The point has been made that the deliberate approach of establishing a controversy, especially in concert with CSR projects aimed at sustainable agriculture, will undermine the long-term approach of crop substitution, rural livelihood diversification, and production exit (Palazzo and Richter, 2005; Mamadu et al., 2008; Bialous, 2008).

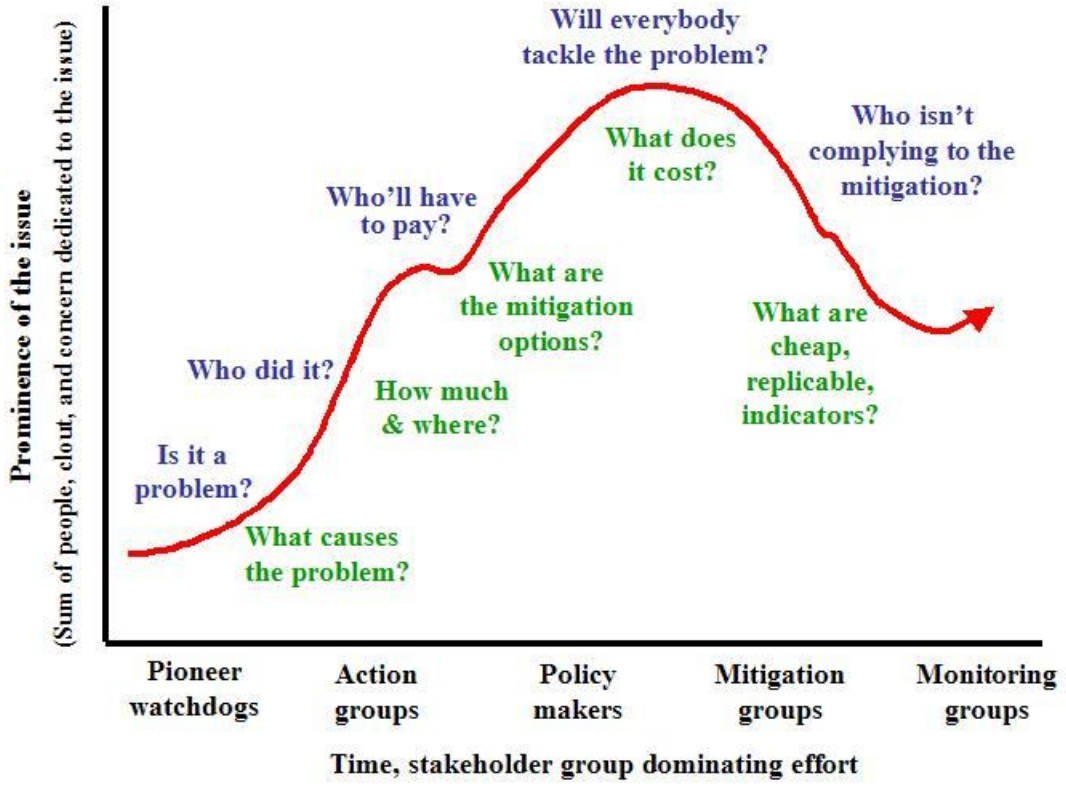
Table 1: Pros and contras of tobacco cultivation from an environment-development perspective (after Keyser, 2007, 5)

Pros	Cons
Tobacco is profitable, easy to grow, and has brought development to rural areas.	Tobacco production is expensive, and farmers are caught in unequal trading relations.
Tobacco is a major contributor to local economies, and demand for cigarettes continues to grow.	Tobacco does not provide a relatively good farming income, and profits arise only outside of local growing areas.
Without tobaccco, farmers could not earn as much income and would have no basis to operate diversification activities.	Tobacco farming has trapped poor growers and most workers into a never-ending debt cycle.
Tobacco supports food production.	Tobacco contributes to rural poverty and food insecurity.
Tobacco is labour intensive and creates more employment per hectare than other enterprises.	Tobacco production exposes farmers and workers, including women and children, to serious (occupational) health risks.
Amount and intensity of pesticides used in tobacco farming are not relevant.	Tobacco is more dependent on hazardous chemicals than many other crops.
Tobacco is less harsh on soils than many other crops.	Tobacco depletes soil nutrients at a much higher rate than many other crops.
With no adequate income from tobacco, pressure upon forests would be worse.	The widespread usage of wood in curing contributes to massive deforestation.
Deforestation due to curing is no negative externality at present.	Deforestation due to curing makes a visible footprint for climate change.
No overall pattern of farmland being ruined and left abandoned because of tobacco has been discovered.	Tobacco farming triggers environmental crisis conditions, namely widespread land degradation and desertification.
Sources	
Fraser, 1986; Campbell, 1995; Tso, 2006; ITGA, 1997, 2007.	Goodland et al., 1984; Madeley, 1986; Chapman, 1994; Parkin, 2000; WHO, 2004, 2008a.

With view upon the life cycle of an environment policy issue (Figure 1), corporate practices and efforts by the agricultural lobby have aimed to establish and still continue a controversy – politically: “is it a problem?”, scientifically: “what causes the problem” (stage 1). Nonetheless, the FCTC has moved the issue further – politically: “who dit it?”, scientifically: “how much and where?” (stage 3). In other words, the public discourse surrounding tobacco as an environment-development concern has entered a phase of “widening acceptance of existence of (potential or actual) environmental impacts, with mounting awareness and pressure for action by authorities” (Tomich et al., 2004, 11). It is expected that the review will contribute to further move the issue onto stage 4 which is the debate on evidence, so that subsequent steps of control and mitigation (stage 5) can be taken under lesss controversial circumstances. The review is thus settled at the interface of science and policy, addressing a broad (rather than narrow or focused) concern which requires

strong and urgent action with view upon building evidence (Corrao et al., 2000; Osborn and Margerison, 2008).

Figure 1: Schematic life cycle of an environmental externality showing how perceptions evolve over time through social interaction and scientific inquiry (Reid et al., 2006, 169)*



* x-axis: groups who focus on an environmental problem; y-axis: prominence of the problem in public discourse; blue, above line: appropriate policy questions; green text, below line: scientific questions.

2. Objective of the Review

2.1 Primary question

To systematically locate, evaluate and synthesize the available published and unpublished evidence in order to answer the question 'Does tobacco cultivation (growing, curing) disrupt ecosystem services in a unique manner', i.e. compared to other cash crops, food crops, and (illicit) drugs ("how much & where?").

2.2 Secondary question

Assuming that each case reveals information on tobacco's actual impact upon ecosystem services, to get a better understanding which type of ecosystem disruption

is most often found in various cultivated and forest/woodland ecosystems and under which contractual (institutional) arrangement ("who did it?").

3. Methods

3.1 Search strategy

In order to locate and identify published as well as unpublished cases of ecosystem disruption by tobacco, the following general electronic/computerised databases, catalogues, and meta-search engines will be searched in combination with specialist websites and resources:

General sources

- ISI Web of Knowledge (web of science abstracts and proceedings)
- Library of Congress, http://www.loc.gov/index.html
- FAO David Lubin Memorial Library, http://www.fao.org/waicent/portal/Virtuallibrary_en.asp
- USDA National Agricultural Library catalogue, http://agricola.nal.usda.org
- ICRISAT Jaswant S. Kanwar Library, http://www.icirsat.org
- CABI resources (CAB abstracts, reviews, archive), http://www.cabi.org
- Elsevier Geo (Geographical, Ecological) Abstracts
- Scirus (personal websites, institutions, repositories), http://www.scirus.com
- COPAC academic and specialist library catalogue, http://www.copac.ac.uk
- Index to theses online, http://www.theses.com (UK, Ireland), [USA?]
- Directory of open access journals, http://www.doaj.org
- Scopus, http://www.scopus.com
- Science direct, http://www.sciencedirect.com
- Journal STORage, http://www.jstor.org
- Google Scholar, http://scholar.google.com

Specialist sources

- CORESTA reports and library websites, http://www.coresta.org
- ITGA trees & tobacco and tobacco literature website, http://tobaccoleaf.org
- The British American Tobacco (BAT) Biodiversity Partnership project website, http://www.batbiodiversity.org/content/projects/projectindex.htm
- WB Economics of tobacco control website, http://www1.worldbank.org/tobacco
- WHO-TFI Economics of tobacco control website, http://www.who.int/tobacco
- FCA Alternative livelihoods and environment website, http://www.fctc.org
- IDRC Research for International Tobacco Control website, http://www.idrc.ca/en/ev-83331-201-1-DO_TOPIC.html
- GLOBALink global tobacco control resources website, http://www.globalink.org
- UNODC crop monitoring, data & analysis and alternative development websites, http://www.unodc.org

- WWF international and national websites, http://www.wwf.org
- PAN resources website, http://www.pan-international.org
- ERF The Rachel database, http://www.ecomall.com/activism/erfund.htm

As for internet searches, using sets of specified keywords, the first 50 hits from each search will be examined (word or PDF documents). Prior to assessment of relevance, all references retrieved will be exported into a bibliographic system. Bibliographies of included material will be searched for further, relevant references. In order to provide missing data and/or updated information, both authors and bodies of relevant articles/material will be contacted. In particular, tobacco-specific databases, catalogues and bibliographies, deemed relevant by individual experts, companies, and institutions (but not identified so far), will be examined. If needed, data centres and/or libraries will be visited for the examination of non-electronic resources not available through interlibrary loan or otherwise (e.g. BAT, CORESTA, FAO, ICRISAT, IDRC-RITC, ITGA, WHO). Following the assessment of relevance, the QUORUM flowchart method is used for further processing relevant references.

The following English language search terms will be used (foreign language searches are considered useful, but not cost effective):

1. tobacco AND ecosystem* (disrupt*, damag*, degrad*, chang*, impact*, imprint)
2. tobacco AND environment* (disrupt*, damag*, degrad*, chang*, impact*, imprint)
3. tobacco AND resource* (disrupt*, damag*, degrad*, chang*, impact*, imprint)
4. tobacco AND land (disrupt*, degrad*, chang*, impact*)
5. tobacco AND soil (disrupt*, degrad*, chang*, impact*)
6. tobacco AND vegetat* (degrad*, deplet*, destruct*, chang*, impact*, loss, damag*, remov*)
7. tobacco AND forest (degrad*, deplet*, destruct*, deplet*, damag*, chang*, loss, remov*)
8. tobacco AND deforestat*
9. tobacco AND woodland (degrad*, deplet*, destruct*, deplet*, damag*, chang*, loss, remov*)
10. tobacco AND biodivers* (degrad*, chang*, impact*)
11. tobacco AND wood (cur*, consumpt*, us*)
12. tobacco AND water* (degrad*, deplet*, pollut*)
13. tobacco AND nutrient (loss, deplet*, declin*, extract*)
14. tobacco AND erosion
15. tobacco AND fertil* (declin*, loss, deplet*, chang*, impact*)
16. tobacco AND intens* (expos*, risk*, hazard*)
17. tobacco AND pesticide* (expos*, risk*, hazard*, poison*)
18. tobacco AND nicotine (dermal, expos*, absorption, uptak*, risk*, hazard*)
19. tobacco AND disease* (expos*, risk*, hazard*, human, occupation*)
20. tobacco AND GTS (green tobacco sickness)
21. tobacco AND health (expos*, risk*, hazard*, hazard, human)
22. tobacco AND mould (dust, lung)

Tobacco as a broad search term will be replaced by the botanical term "*N. tabacum*" (*Nicotiana tabacum*), if appropriate. Likewise, specifications of naturally versus artificially cured tobacco varieties (altogether 7), including acronyms, will be used, if appropriate (USDA-FAS, 1994, 1997; Davis and Nielsen, 1999; Keyser, 2007), and more local names may be added once revealed during the review:

1. artificially AND cur*
2. flue
3. flue AND cur*
4. Virginia
5. FCV
6. VCF
7. Bright
8. fire AND cur*
9. dark AND fire*
10. naturally AND cur*
11. air AND cur*
12. Burley
13. light AND air
14. dark AND air
15. sun AND cur*
16. dark AND sun
17. oriental

3.2 Study inclusion criteria

The inclusion criteria below will be applied by trained support staff to all potential studies at the level of title and abstract, proceeding to full text assessment as necessary. The lead reviewer will examine a random subset of at least 25% of the reference list for repeatability of the selection criteria.

- **Relevant subjects**: Contemporary disruption of four types of ecosystem services (supporting, provisioning, regulating, cultural) in the post-1960 era with regard to three constituents of human well-being (security, basic material for good life, health) in areas where tobacco is grown (cultivated systems) and from which resources (wood, land) are drawn for the cultivation of tobacco (forest and woodland systems) (MA, 2003; Cassman et al., 2005; Shvidenko et al., 2005).

- **Types of intervention**: Growing and curing of tobacco in areas of developing countries (as defined by the UN system; FAO, 2008), i.e., any kind of on-farm land use, land management, crop husbandry and pre/post-havest activity related to any type of tobacco at the subnational level.

- **Types of comparator**: Any other (non-tobacco) cropping system, i.e., food and cash crops (including tree crops) and illicit drugs (cannabis, coca, opium poppy, khat).

- **Types of outcome**: Disruption of supporting ecosystem services (uptake of N-P-K-nutrients, soil contamination, overfertilisation), provisioning ecosystem mservices (food insecurity, usage of fuelwood and polewood in curing and barn

construction, vegetation change/biodiversity loss such as forest degradation and deforestation), regulating ecosystem services (erosion, water contamination, human/occupational diseases such as pesticide poisonings and green tobacco sickness), and cultural services (genetic erosion, environmental/landscape simplification) in terms of extent, intensity and rate of change.

- **Types of study**: Striving to obtain relevant literature, studies need to have site-specific information only (i.e., no laboratory or field experiments). A wide array of materials will be consulted, ranging from grey literature (e.g., commissioned consultancy work) and public testimonies to books, and journal articles (see 3.4 for a quality ranking of studies).

3.3 Potential effect modifiers and reasons for heterogeneity

The main effect modifiers associated with the results of the studies relate to time (i.e., point-in-time or between-time-point studies), the different methodological quality of the studies (see also 3.4), and on- *versus* off-farm factors involved (e.g., availability and sources of wood for curing). The general factors for heterogeneity include initial conditions (ecology, land use), causal clusters (proximate causes, underlying driving forces), and feedbacks (societal, ecological) (Geist, 2006), while tobacco-specific factors that may influence the outcome of the study can be detailed as follows:

- Type of tobacco grown
- Land use history (position in production cycle, old *versus* new growing area)
- Environmental history (changes in climate, soil, vegetation, and water)
- Mode of contractual arrangement (state monopoly, private company)
- Type of environmental governance (state, civil society, company)
- Modification of land use practices (crop rotation, afforestation)
- Modification of curing practices (burning technology, energy source)

In addition, heterogeneity may also arise from different outcome measures such as the number of trees (logs, poles) used in the on-farm curing of all green leaf harvest *versus* standardised measures such as specific fuelwood consumtion (SFC), i.e., amount of wood (in kg) used to cure 1 kg of tobacco leaf (Fraser, 1991).

3.4 Study quality assessment

In an effort to minimise bias, materials found and evaluated are ranked according to three quality categories:

- low-quality studies: unpublished grey literature (crop reports, research findings), commissioned consultancy work (published, or not), and (published) testimonies at public hearings,
- medium-quality studies – books, book chapters, published (crop monitoring) reports, non-peer reviewed journal articles;
- high-quality studies – peer-reviewed articles in internationally recognised journals.

A rule from investigative journalism is adopted which states that information can be considered reliable only if confirmed by at least two independent sources. Thus, information in testimonies from the public hearings about issues of agricultural diversification (WHO, 2007) needs to be confirmed (repeated) in independently produced reports, books, book chapters, and journal articles, fore xample. Due to their strict peer review, scientific articles published in international journals accredited by the ISI Web of Knowledge are seen to be of highest priority and would need no further confirmation by other sources.

Since the organisation funding the review has appointed a single lead reviewer assisted by one part-time support staff member only, it may be crucial to include subject experts at this stage. Thus, agreement is resolved by consensus between lead reviewer and support staff, or following assessment by an independent subject expert who is not affiliated with the tobacco industry.

3.5 Data extraction strategy

Based on the search for reported impacts of tobacco farming upon ecosystems in title, abstract and, finally, full text, a review-specific data extraction form is applied per each piece of literature or ducument found. The form is tested in a pilot phase with the goal to modify and amend as necessary to ensure repeatability. A database or spreadsheet of all information relevant to the review will be used for application of the QUORUM flowchart statement to characterise and quantify excluded *versus* included studies, sources of studies, and types of disrupted ecosystem services. Rather than building upon the generalised results from existing meta-analyses – e.g., Geist (1999) on deforestation and Schmitt et al. (2007) on occupational health hazards related to tobacco farming – individual studies from these works will be used and evaluated by using the review-specific data extraction form as necessary. Also, authors will be contacted for a potential update of their list of case studies. Assuming that no study covers the full range of potential ecosystem disruptions, authors and/or organisations will be contacted, as necessary, for the retrieval of missing data per ecosystem service considered.

3.6 Data synthesis and presentation

Assuming that each selected case study reveals information on tobacco's actual impacts upon ecosystem services, and based on the data extraction form, an evaluation and subsequent coding of data is perforemd, using standard statistical software. Data availabilty allows for both qualitative synthesis and quantitative analysis in a portfolio approach. Thus, a middle-way is taken between (qualitative, descriptive, narrative) case studies and (quantitative) variable-oriented research, combining the strenghts of within-case analysis (e.g., per growing area) and cross-case analysis (e.g., identification of patterns across growing areas) (Shenhav 2005; Newell et al., 2005; Young et al., 2006).

As for the quantitative analysis, a meta-analytical design will be applied to pool the results of individual studies (Hedges and Olkin, 1985; Osenberg et al., 1999; Lipsey and Wilson, 2001, Rudel, 2008). An application of formal statistical procedures intends to estimate the frequency of occurrence of causative factors of disruption (e.g., source, type and amount of wood used in curing) and to semi/quantify the

extent, intensity and rate of disruption per ecosystem service (e.g., rate of deforestation in tobacco-growing *versus* non-tobacco growing areas). As necessary, heterogeneity in data will be protcolled graphically or tested statistically (Q statistics), and quantitative pooling will be done separately for subgroups of studies according to study-level variables (se 3.3) and ecosystem services.

Assuming that each study identifies one or more types of disruptions of ecosystems associated with tobacco farming, the presentation applies a comparative perspective: which impacts due to growing and curing of tobacco are reported and thus most often found in various cultivated and forest/woodland systems of the developing world in terms of extent, intensity and rate, and how do these insights relate to other crops grown (cash crops, food crops, drugs). The comparative view allows a breakdown by:

- types of (disrupted) ecosystem services
- broad geographic regions (Latin America, Africa, Asia)
- individual tobacco varieties
- features of the the ecosystem/growing area (size, location, lowland versus upland, semi(arid) versus (sub)humid)
- features of the producer country (environmental governance, development status, position in the global tobacco market)
- tobacco (as an aggregate entity) and other crops
- commissioned tobacco-industry *versus* independent studies.

As for the latter breakdown, the configurational comparative research design focuses on multiple conjunctural causation with positive cases, i.e., selecting cases that do not differ greatly from each other with respect to the outcome (disrupted ecosystem services). Thus, it cannot be excluded that the review tends to be biased towards a positive result. Given the controversies still surrounding tobacco as an environment-development issue, and in order to contribute to the urgent creation of an unbiased evidence-base (see 1), particular attention will be given to reduce vested interest-driven, publication-related biases. Thus, the breakdown as proposed here may show the way forward how to relate to the pros and cons compiled in table 1.

4. Potential Conflicts of Interest and Sources of Support

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