

# Virtual Water in Food Production

## Introduction

The water consumed in the production process of an agricultural or industrial product has been called the 'virtual water' contained in the product (Allan 1998). If one country exports a water intensive product to another country, it exports water in virtual form. In this way some countries support other countries in their water needs. For water-scarce countries it could be attractive to achieve water security by importing water-intensive products instead of producing all water demanding products domestically (WWC 1998). Reversibly, water-rich countries could profit from their abundance of water resources by producing water-intensive products for export. Trade of real water between water-rich and water-poor regions is generally impossible due to the large distances and associated costs, but trade in water-intensive products (virtual water trade) is realistic (Hoekstra and Hung 2002). Virtual water trade between nations and even continents could thus ideally be used as an instrument to improve global water use efficiency, to achieve water security in water-poor regions of the world and to alleviate the constraints on environment by using best suited production sites (Turton 2000).

## Primary product

Cereals, vegetables and fruits fall into this category for which the relationship between water consumption and production is quite clear. Production (kg) and water evapotranspired ( $m^3$ ) are estimated at field level and are the basis of the virtual water value estimation ( $m^3/kg$ ), possibly adjusted with efficiency factors. These products are assessed as primary products even though sometimes transformed afterwards (e.g. fruit juice).

## Processed products

These are the food items that are produced by processing primary products. Vegetal processed products include sugar (sugarcane, sugar beet), oil from various primary product, and alcoholic beverages.

## Transformed products

Animal products must be considered as transformed products as their production using primary vegetal products (cereals, grass, other by-products). Two continents, America and Oceania, are net exporters of virtual water. They represent 51% of the exported virtual water. In particular, the exports of Oceania are much more important than their own consumption. Two continents, Asia and Africa, are net importers of virtual water. They represent 46% of the imported virtual water. European Union occupies a specific place since it imports and exports high quantities of virtual water with a net balance almost equal to zero. It is right time for Nepal to consider virtual water to take advantages of its vast unused water sources that is flowering act of the country.

## Appendix

Table A1. Specific Water Demands or primary vegetal products (Values estimated for 1990)

Products	Specific Water Demand ( $m^3/T$ )	Country, Reference
Wheat, millet, rye	1159	California, Barthelemy et al
Barley	1910	California, Barthelemy et al
Sorghum	542	Egypt, Barthelemy et al
Rice	1408	California, Barthelemy et al
Maize	710	California, Barthelemy et al
Cereals, others	1159	California, Barthelemy et al
Sugar beet	193	California, Barthelemy et al
Sugar Cane	318	California, Barthelemy et al
Pulses	1754	Egypt, Barthelemy et al, TS and FAO databases
Sunflower	3283	Egypt, Barthelemy et al, TS databases
Tomatoes	130	California, Barthelemy et al
Oranges and other citrus	378	California, Barthelemy et al

Table A2. Specific Water Demands or transformed or processed products (Values estimated for 1990)

Products	Specific Water Demand ( $m^3/T$ )	Country, Reference
Sunflower seed oil	7550	California, Barthelemy et al
Rape and Mustard oil	3500	Germany, BRL data base
Soybean oil	5405	Egypt, Barthelemy et al, TS and FAO databases
Bovine, mutton, goat meat	13500	California, Barthelemy et al
Pig meat	4600 <sup>1</sup>	California, Barthelemy et al
Poultry meat	4100	California, Barthelemy et al
Other meat	13500	California, Barthelemy et al
Eggs	2700	California, Barthelemy et al
Milk	790	California, Barthelemy et al
Butter + Fat	18000	California, Barthelemy et al

<sup>1</sup> value to be debated in countries where pig is fed mainly with waste products

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