Why Food Safety Will Continue Driving Growth in Demand for Organic Food

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Imagine if Ford Motor Company designed an engine that could double gas mileage with no loss in performance, or if General Electric discovered a fully recyclable light bulb that lasts three times longer than those on the market today. Would these companies tout these attributes in their advertising campaigns? You bet they would.

Over the last two decades the organic community has had a love-hate relationship with food safety issues in general, and pesticide risks in particular. For the most part, the community has chosen to not prominently feature food safety as a reason to "buy organic," and instead has focused messages targeting consumers on freshness and taste, and the environmental and soil quality benefits of organic farming systems and technologies.

Anti-pesticide activists have not shown the restraint evident across the organic food industry. They have embraced organic farming as the surest way to reduce pesticide use and risks. The message is getting through. A majority of consumers in virtually all surveys voice significant concerns over pesticides in food. In "The Packer's" *2003 Fresh Trends* survey, 63 percent of shoppers buying organic food stated a preference for "fewer chemicals in food" and 51 percent said organic food is "Better for me/my family." The next most frequently cited reason – "Better for the environment" – was identified by 37 percent of those surveyed.

For reasons beyond the control of the organic community, there is now a raging food safety, food quality debate underway around the world. It is focusing on the impacts of different farming systems and technologies – conventional farming versus biotech versus IPM versus organic. The Stossel 20/20 episode and recent NOP rule-related PR from conventional ag interests shows how low those threatened by the success of organic farming will go in trying to shake consumer confidence in organic food. Hopefully the organic community now realizes that the industry's critics must not be allowed to set the tone and drive the direction of this very important debate.

Activists opposing genetic engineering (GE) around the world have been criticized in the media as paranoid and anti-progress. Some have stumbled when asked "…well, if GE is not the answer, how would you solve today's food production and food security challenges?" With increasing frequency, activists point to organic farming as the more desirable technological path. Proponents of biotech have not been bashful in responding.

This debate is long over due, important, and ultimately, should be constructive. There are profound differences between the principles driving today's GE applications in agriculture versus the principles underlying organic farming. The sooner the public understands these differences and decides which set of principles should shape their food future, the sooner the country can progress toward more coherent national food, farm, and technology policies. Today's muddling serves no one well.

New Science Supports a Positive Food Safety Message

There is new information on both the exposure and toxicity side of the pesticide risk assessment equation.

Much new data on pesticide residues in food has emerged as a result of the passage of the Food Quality Protection Act (FQPA) in 1996. This historic bill directed the U.S. EPA to conduct a reassessment

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of all food uses of pesticides, taking into account the heightened susceptibility of infants and children, the elderly, and other vulnerable population groups.

Why the focus on risks to infants and children? Because kids, especially, infants consume more food per kilogram of bodyweight than adults do and a much less varied diet. As a result, exposure to a pesticide from consumption of a given food is greater per kilogram of infant/child bodyweight compared to adults (National Research Council, 1993). Plus, exposure to some pesticides during infancy, even at very low levels, can lead to serious life-long consequences if the pesticides disrupt hormone-driven developmental processes.

In the early 1990s surprisingly little was known about the frequency or levels of pesticides in food as actually eaten. Then-existing government data on residues had been collected as part of tolerance enforcement programs and represented residues at the farm gate, prior to washing, shipping, storage, marketing, and preparation. Relatively insensitive analytical methods were used.

To improve the accuracy of FQPA-driven pesticide dietary risk assessments, Congress funded a new USDA program in 1991, the "Pesticide Data Program" (PDP). By design, the PDP focuses on the foods consumed most heavily by children and food is tested, to the extent possible, "as eaten" (Agricultural Marketing Service, 2002). (A banana or orange samples are tested without the peel; processed foods are tested as they come out of a can, jar or freezer bag).

Ten years of PDP testing has greatly enhanced understanding of pesticide residues in the United States food supply. About a dozen foods are tested annually. Some 600 to 650 samples are tested of each fresh or processed food, reflecting domestic production and imports roughly proportional to their respective share of overall consumption. Plus, market claims associated with a given food item, such as "organic," "IPM-grown," "No Detectable Residues" or "pesticide free," are recorded roughly in proportion to their occurrence in retail market channels (Baker et. al., 2002). As a result, PDP results make possible comparison of the distribution and frequency of pesticide residues in domestic versus imported foods, across food groups, as well as comparisons by market claim (Groth, et al., 2000).

The first-ever analysis of pesticides in organic versus conventional foods was published in the peer-reviewed journal *Food Additives and Contaminants* in early 2002 (Baker et al., 2002). I was among the authors. The full team included Brian Baker, OMRI's Director of Research, Ned Groth of Consumers Union, and Karen Lutz Benbrook. The paper analyzed six years of PDP data, 10 years of California Department of Pesticide Regulation (DPR) data, and results of Consumers Union testing of four crops. The PDP data covered program years 1994-1999, and the DPR data, 1989 through 1998. A set of four tables in the appendix provides key findings from recent analysis of PDP, DPR and Consumers Union residue data sets.

After summarizing the findings of the *Food Additives and Contaminants* paper, two tables are presented with more recent data comparing residues in organic and conventional food. One covers residues found by DPR in 1999 and 2000 testing and a second presents the results of testing carried out in 2001 and 2002 by the British government.

An Overview of Pesticide Residues in Conventional and Organic Foods

Some major food groups – most oils, dairy, meat, and poultry products – contain few detectable pesticides and contribute very modestly at the national level to dietary exposure and risk. About a dozen pesticides are present routinely in fresh produce and juices derived from produce at levels that pose significant risks, to the extent contemporary risk assessment science and toxicological data accurately reflects real-world risks.

Despite much new data and more refined risk assessment methods, several key children's foods still contain worrisome pesticide residues six years after passage of the FQPA (Consumers Union, 2001). The foods most likely to contain residues of high-risk pesticides are apples, pears, peaches, grapes, green beans, tomatoes, peas, strawberries, spinach, peppers, melons, lettuce, and various juices.

Nearly three-quarters of the fresh fruits and vegetables (F&V) consumed most frequently by children in the U.S. contain residues and almost half the F&V samples tested from 1994-1999 in the PDP contain two or more residues (Baker et al., 2002). In general, soft-skinned fruit and vegetables tend to contain residues more frequently than foods with thicker skins, shells, or peels.

The pattern of residues found in organic foods tested by the PDP differs markedly from the pattern in conventional samples. Conventional fruits are 3.6 times more likely to contain residues than organic fruit samples and conventional vegetables are 6.8 times more likely to have one or more detectable residue.

Compared to organic produce, conventional samples also tend to contain multiple residues much more often. Imported foods consistently contain more residues than domestic samples, regardless of market claim.

Averaged across the PDP and DPR data sets, just under 7 percent of positive organic samples and 54 percent of positive conventional samples contained multiple residues (see Appendix tables). The average positive conventional apple sample contained 3.2 pesticides, peaches contained 3.1 residues, and celery and cucumber contained 2.7 (Baker et al., 2002).

Data from DPR testing in 1999 and 2000 shows that conventional food is more than five-times more likely to contain residues than organic samples. It is worth noting that organic farmers, processors, and retailers are doing a better job in preventing fraud and pesticide drift and other inadvertent residues, given the downward trend in the frequency of residues in organic foods. In 1996-1998 testing by DPR, just over 12 percent of organic samples tested positive on average, while 7.1 percent contained detectable residues in 1999-2000. There was little change in the frequency of residues in conventional foods, which averaged 38.3 percent annually from 1996-1998 and 40 percent in 1999-2000.

Table 1. Overview of Pesticide Residues in Food Tested by the California Department of Pesticide Regulation, 1999-2000

	Organic Samples			No Market Claim Samples		
	Number	Number Positive	Percent Positive	Number	Number Positive	Percent Positive
1999 Testing	170	7	4.1%	7,823	3,243	41.5%
2000 Testing	139	15	10.8%	7,894	3,049	38.6%
1999 + 2000	**309**	**22**	**7.1%**	**15,717**	**6,292**	**40.0%**

Source: Compiled by Benbrook Consulting Services based on reports issued by the California Department of Pesticide Regulation, accessible at http://www.cdpr.ca.gov/docs/pstrsmon/resi1998/rsfr1998.htm

There is growing interest in Europe in comparing the residues in food produced by conventional versus organic farmers. The British government reported residue findings in organic food samples for the first time in 2001, allowing comparisons to residue frequency in conventional foods. The results to date are summarized in Table 2.

The analytical methods used by the British Pesticide Residue Committee are not as broad or sensitive as those used in the PDP, and hence the percent of samples testing positive are lower in both conventional and organic foods. But the differences between conventional and organic foods remain. Over 250 samples of organic foods have been tested by the PRC since 2001 – more samples than tested by the PDP over 10 years. Just under 27 percent of all samples tested positive, while 3.6 percent of organic samples contained a detectable pesticide residue. Hence, based on British testing, conventional foods are 7.5 times more likely to contain detectable residues than organic foods.

Table 2. Overview of Pesticide Residues in Food Tested by the Pesticide Residue Committee (PRC) in Great Britain, 2001-2002

	PRC 2001				
	Number of Samples	**Percent Positive**	**Percent Multi-residue**	**Number Organic Samples**	**Percent Organic Positive**
Fruit	1,411	34.9%	19.8%	24	4.2%
Vegetable	1,193	26.7%	5.7%	41	7.3%
Grain	311	33.4%	11.9%	12	0.0%
Meat/Dairy	795	15.3%	4.2%	50	4.0%
Other	168	7.1%	2.4%	10	0.0%
Prepared	432	30.3%	6.5%	55	3.2%
All Foods	4,310	27.1%	10.6%	192	4.2%
	PRC 2002 (1st and 2nd quarters)				
	Number of Samples	**Percent Positive**	**Percent Multi-residue**	**Number Organic Samples**	**Percent Organic Positive**
Fruit	308	62.7%	36.4%	15	0.0%
Vegetable	375	26.7%	6.9%	11	0.0%
Grain	48	56.3%	2.1%	0	0.0%
Meat/Dairy	534	10.9%	0.0%	23	4.3%
Prepared	192	3.1%	0.0%	12	0.0%
All Foods	1,457	26.4%	9.6%	61	1.6%
	2001 and 2002 (1st+2nd quarters) Combined				
All Foods	5,767	26.9%	10.3%	253	3.6%

Source: Compiled by Benbrook Consulting Services based on reports issued by the Pesticide Residue Committee, Department for Environment, Food and Rural Affairs, U.K. Reports accessible at http://www.pesticides.uk.gov, click on "Committees," and then "PRC."

Pesticide Toxicity

Implementation of the FQPA triggered an explosion in toxicological and risk assessment research on the developmental effects of pesticides. During fetal development and the first years of life, infants are much less able to detoxify most pesticides and are uniquely vulnerable to developmental toxins, especially neurotoxins, given that the brain and nervous system continue developing through about age 12 (National Research Council, 1993; Eskenazi et al., 1999).

New toxicological data have forced downward by one to two orders of magnitude the allowable levels of exposure to various pesticides found in food (Office of Pesticide Programs, 2002; Gray et al., 1999). The EPA has had to phase out hundreds of food uses of relatively high-risk pesticides (mostly organophosphate insecticide uses) in order to meet the FQPA's new "reasonable certainty of no harm" standard (Consumers Union, 2001).

In the last decade much new evidence has emerged on the mechanisms through which pesticides can disrupt development as a result of even very low exposures. Literature through early 1999 is summarized in a special issue of the journal *Toxicology and Industrial Health* (Colborn et al., 1999). Just a few examples follow focusing on research published since the 1999 review. A review article published in *San Francisco Medicine* in November 2002 targets lay audiences and provides a useful update on recently published research findings on endocrine disruptors and human health, including several studies on pesticides (Myers, 2002).

University of California-Berkeley School of Public Health scientists found that exposures to pesticides during pregnancy significantly heightened risk of children developing leukemia and that the more frequent the exposures and the earlier in life, the greater the increase in risk (Ma et al., 2002). A team in the Department of Preventive Medicine, University of Southern California, found that exposure to pesticides in the home during fetal development increased the risk of Non-Hodgkin's lymphoma, with odds ratios as high as 9.6 for Burkitt lymphoma (Buckley et al., 2000).

A study in Ontario, Canada confirmed that exposures to pesticides three months prior to conception and during pregnancy increased the risk of spontaneous abortions (Arbuckle et al., 2001).

Research supported by the French Ministry of Environment documented clear linkages between exposures to pesticides commonly used in grape vineyards and long-term adverse cognitive effects (Baldi et al., 2001). Cognitive performance was compared in a group of children living in an upland agricultural region in Mexico where substantial pesticide use occurred, compared to a similar cohort in a nearby village. Children exposed to pesticides had lessened stamina and attention spans, impaired memory and hand-eye coordination, and greater difficulty making simple line drawings (Guillette et al., 1998).

Just-published work on the developmental neurotoxicity of the most widely used insecticide in the United States, chlorpyrifos, showed that this organophosate (OP) targets neural cell replication and differentiation, as well as the functioning of glial cells (Qiao et al., 2002). The authors conclude that exposures to this OP during the first few years of life are likely a greater risk than during fetal development, although prenatal exposures appear to disrupt the architectural organization of specific regions in the brain and the development of the fetal liver.

Antiandrogenic pesticides have been shown to cause demasculinization in several species by blocking the receptor sites needed for male sexual hormones to perform their normal functions during development (Baatrup and Junge, 2001; Gray et al., 1999).

The most compelling new study to appear on pesticide dietary risks in a long time was published online on October 31, 2002 in the highly respected journal *Environmental Health Perspectives*. A team based at the University of Washington's School of Public Health and Community Medicine carried out the research. The research assesses the difference in organophosphate (OP) residues and risk faced by two to five year olds consuming a diet composed of mostly organic foods versus conventional foods (Curl et al., 2002). The abstract of this important study appears following the appendix tables.

The team found that two to five year olds consuming mostly organic foods over a three day period had much lower mean levels of organophosphate (OP) insecticide metabolites in their urine – in fact, children consuming conventional food had 8.5 times higher average levels than children eating mostly an organic diet. The study was carefully designed to avoid other potential confounding variables. The children came from similar socio-economic backgrounds; households with recent use of pesticides in the home were excluded from the study; and rigorous sampling and double-blind testing protocols were used. The research team also correlated differences in OP metabolite levels to likely risk levels, as measured by the EPA. They concluded that:

> "Dose estimates generated from pesticide metabolite data suggest that organic diets can reduce children's exposure levels from above to below EPA's chronic reference doses, thereby shifting exposures from a range of uncertain risk to a range of negligible risk. Consumption of organic produce represents a relatively simple means for parents to reduce their children's exposure to pesticides." (Curl et al., 2002)

The pesticide residue data reviewed earlier provides a solid basis to predict a substantial difference in exposure among people consuming largely conventional versus largely organic food. Moreover, it is clear that fresh fruits and vegetables, and fruit juices, account for the lion's share of dietary exposure. The Curl study provides the first direct empirical confirmation of this prediction and moreover, supports the encouraging conclusion that by switching to predominantly organic produce and fruit juices, a child's pesticide exposures can be reduced to negligible levels, unlikely to pose significant risks, during this critical period of development.

Organic farmers and consumers are not the only ones that should rejoice at these findings. Conventional farmers adopting biointensive Integrated Pest Management systems can also markedly reduce OP insecticide use. Extensive evidence compiled by the EPA over the course of implementing the FQPA suggests that by cutting out all OP sprays within 90 to 120 days of harvest on major kids' foods, OP residues will largely, if not fully disappear from fresh produce. This is also good news for EPA, which can now confidently predict major progress in reducing OP risks following a relatively small number of regulatory actions targeting less than two-dozen foods.

Why Organic Food Sometimes Contains Residues

Many people wonder why between 10 percent and one-quarter of organic F&V samples contain residues of synthetic pesticides. Like transgenic DNA, pesticides are ubiquitous and mobile across agricultural landscapes. Most positive organic samples contain low levels of pesticides used on nearby conventional fields. They move onto organic food via drift or through use of contaminated irrigation water. Soil-bound residues of persistent pesticides account for a large portion of residues in root crops and squashes. Cross-contamination with post-harvest fungicides applied in storage facilities is a major cause of low-level fungicide residues (Baker et al., 2002). The small percent of samples sold as organic and found to contain relatively high levels of residues likely arise from inadvertent mixing of produce, laboratory error, mislabeling, or fraud.

A few pro-pesticide activists have gone to great lengths to convince consumers that pesticide residues in organic food are as risky as those in conventional foods. Fortunately, these claims do not pass the laugh test. Expanded residue testing of botanicals and biopesticides would be needed to decisively settle the empirical issues behind such specious claims. Settling this artificial controversy would mean less testing to better understand significant pesticide dietary risks, a tradeoff thus far rejected by government regulatory and research agencies.

It is also true that organic farmers apply non-synthetic pesticides including sulfur, oils, several botanicals, *Bacillus thuringiensis* (*Bt*), soaps, certain microbial pesticides, and pheromones.

By volume, major pesticides used on both organic and conventional farms include sulfur, horticultural/petroleum distillates and oils, and copper-based fungicides. There are some formulations of these pesticides approved for organic production and many others available to conventional growers. These pesticides are used in similar ways for comparable reasons on organic and conventional fruit and vegetable farms. Sulfur is almost certainly the most common pesticide residue present on conventional and organic F&Vs, but it is never tested for because it is exempt from the requirement for a tolerance and poses essentially no risk through the diet. Copper is also not tested for because of tolerance exemptions and the fact that copper is an essential nutrient and harmless at the levels ingested as food residues.

Organic farmers also rely on *Bacillus thuringiensis* insecticides, pheromones, and products that coat produce with nontoxic, biodegradable materials (e.g., soaps and clays). Residues of these pesticides are rarely tested for because there are no tolerances to enforce and no basis for food safety concerns, given how these products are used in production agriculture.

While there were once several toxic botanical insecticides on the market and approved for organic production, only one remains in relatively common use – pyrethrins. Pesticides containing pyrethrins are indeed toxic but they degrade rapidly after spraying and hence rarely leave detectable residues. Plus, they are applied at very low rates, on the order of one to two one-hundredths of a pound per acre; OP insecticides are applied at 50- to 100-times higher rates. Other botanicals of possible concern include rotenone and sabadilla. The most recent survey of organic farmers carried out by the Organic Farming Research Foundation (OFRF) found that only 9 percent of 1,045 farmers applied botanicals regularly (mostly pyrethrins and neem), and that 52 perent never use them, 21 percent use them rarely, and 18 percent "on occasion" (Walz, 1999).

Two Closing Thoughts

To the extent consumers become aware of recently published data and research findings on pesticides in food, new information will reinforce already deep-set concerns. It is now clear that purchasing organic food is a reliable way to markedly reduce exposure to pesticides. Less exposure means greater margins of safety. While toxicologists and risk assessment experts will argue until the cows come home over whether 0.05 ppm of pesticide X, Y, or Z is safe or unsafe, many consumers are now looking for practical ways to reduce personal risk loads. Consuming organic food is clearly one way to do just that.

Several times in recent years, the USDA has stated publicly that organic food is no safer than any other food. Even more frequently and assertively, the USDA has claimed that GE foods are fully tested and pose no risks. Bush administration and USDA leaders are puzzled why so many people around the world are not willing to accept the official position of the U.S. government regarding the safety of GE foods. The credibility of the U.S. government, and confidence around the world in food exports from the U.S., rests upon whether food safety conclusions reached by the USDA, and pushed by the government, are grounded in sound science and consistent with the latest research findings. Clearly, the U.S.D.A. needs to look anew at recent data on pesticide residues in conventional and organic foods and reconsider its message, in the interest of restoring confidence in the Department's scientific abilities and openness to new information.

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Appendix Tables

Table 1. Frequency of Pesticide Residues in Fresh Fruits and Vegetables by Market Claim; Pesticide Data Program 1994-1999 (see note)

	Organic				No Market Claim		
	Number of Samples	Number of Positives	Percent Positive		Number of Samples	Number of Positives	Percent Positive
Eight Fruits	30	7	23%		12,612	10,287	82%
Twelve Vegetables	97	9	9%		13,959	8,465	61%
All Fresh Foods	127	16	13%		26,571	18,752	71%

Note: Residues of long-banned organochlorine insecticides and their metabolites are not included.

Source: Data from Table 2 in (Baker et. al., 2002).

Table 2. Organic, Pesticide Free and NDR Samples in 2000 Testing Carried Out by USDA's Pesticide Data Program (PDP)

	Number of Samples			Number of Positives			Percent Positive		
Market Claim	Domestic	Import	Total	Domestic	Import	Total	Domestic	Import	Total
Conventional	6,780	2,014	8,794	4,314	1,563	5,877	64%	78%	67%
Organic	39	9	48	7	3	10	18%	33%	21%
NDR	5	3	8	4	3	7	80%	100%	88%
All Market Claims	**6,824**	**2,026**	**8,850**	**4,325**	**1,569**	**5,894**	**63%**	**77%**	**67%**
	Number of Samples			Number of Positives			Percent Positive		
	Domestic	Import	Total	Domestic	Import	Total	Domestic	Import	Total
Organic Fruits and Vegetables									
Cantaloupe	6	1	7	0	1	1	0%	100%	14%
Carrot	3	1	4	2	0	2	67%	0%	50%
Green Bean	2	2	4	1	0	1	50%	0%	25%
Lettuce	5	0	5	0	0	0	0%	-	0%
Orange	9	0	9	1	0	1	11%	-	11%
Strawberry	4	0	4	0	0	0	0%	-	0%
Bell Pepper	4	2	6	2	0	2	50%	0%	33%
All Other	6	3	9	1	2	3	17%	67%	33%
All Organic Produce	**39**	**9**	**48**	**7**	**3**	**1**	**18%**	**33%**	**21%**
	Number of Samples			Number of Positives			Percent Positive		
	Domestic	Import	Total	Domestic	Import	Total	Domestic	Import	Total
Conventional Fruits and Vegetables									
Apple	180	4	184	141	4	145	78%	100%	79%
Cantaloupe	186	214	400	74	158	232	40%	74%	58%
Carrot	163	16	179	137	9	146	84%	56%	82%
Cherry	275	0	275	259	0	259	94%	-	94%
Cucumber	392	337	729	262	305	567	67%	91%	78%
Grape	393	339	732	220	287	507	56%	85%	69%
Green Bean	581	113	694	395	82	477	68%	73%	69%
Lettuce	720	12	732	265	8	273	37%	67%	37%
Nectarine	341	2	343	335	2	337	98%	100%	98%
Orange	701	22	732	569	20	589	80%	91%	80%
Peach, Composite	273	260	533	249	252	501	91%	97%	94%
Peach, Single	272	259	531	248	247	495	91%	95%	93%
Pear, Canned	354	8	362	22	1	23	6%	13%	6%
Pineapple	149	215	364	4	16	20	3%	7%	5%
Potato	364	4	368	257	1	258	71%	25%	70%
Strawberry	493	20	513	451	19	470	91%	95%	92%
Strawberry, Frozen	36	1	37	29	1	30	81%	100%	81%
Bell Pepper	538	187	725	357	151	508	66%	81%	70%
Tomato, Canned	360	1	361	40	0	40	11%	0%	11%
All Conventional Produce	**6,780**	**2,014**	**8,794**	**4,314**	**1,563**	**5,877**	**64%**	**78%**	**67%**

Source: Benbrook Consulting Services, derived from the results of year 2000 PDP Program Testing (AMS, 2000)

Table 3. Number of Residues Found in 2000 PDP Testing by Type of Claim and Source of Produce

Market Claim	Number of Unique Residues Found			Average Number of Residues per Positive Sample		
	Domestic	Import	Total	Domestic	Import	Total
Conventional	9,559	4,903	14,462	2.2	3.1	2.5
Organic	7	8	15	1.0	2.7	1.5
NDR (“Pesticide Free” & “No Pesticides Detected”)	6	17	23	1.5	5.7	3.3

Source: Benbrook Consulting Services, derived from the results of year 2000 Pesticide Data Program testing (AMS, 2002)

Table 4. Occurrence of Multiple Residues by Market Claim in PDP and Consumers Union Dataset

	Organic Samples with Multiple Residues		IPM/NDR Samples with Multiple Residues		No Market Claim Samples with Multiple Residues	
	Number	Percent	Number	Percent	Number	Percent
PDP 1994-1999 (20 Crops)	9	7.1%	46	24%	12,102	45.5%
Consumers Union (4 crops)	4	6%	20	44%	42	62%
Average Two (2) Datasets		6.5%		34%		53.6%

Note: Residues of long-banned organochlorine insecticides and their metabolites are not included

Source: Data from Table 5 in (Baker et. al. 2002)