

*Review Article*

**Cottonseed Oil as Health Oil**

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**ABSTRACT**

There are varieties of cooking oil and fat available today and the claims made by them are, at best, confusing. On one side are the traditional ghee, mustard oil, coconut oil, and gingelly oil. Then, there are the used-for-decades vanaspati and groundnut oil, as well as the relatively newer kinds of vegetable oil ranging from cottonseed, sunflower, safflower, corn, canola, soybean, and palm to various blends. In particular, cottonseed oil performs better than other oil as it lasts a long time and stores well by withstanding higher temperature for food items due to its high antioxidant content. For instance, chips and snacks fried in cottonseed oil may maintain a longer shelf life. It is a good option for preparing healthier foods. The purpose of this paper is to highlight the value of addition cottonseed oil in the food industry and presents an insight into other contemporary edible oil. It is important to note that buying the right oil for health has become a big deal.

**Keywords:** Cottonseed oil, edible oil, fatty acids, gossypol, health oil, trans fat, vegetable oil

**INTRODUCTION**

Cottonseed oil, a by-product of cottonseed, is a valuable source of edible oil. The whole cottonseed contains 15-20% oil and about 30-38% of kernel, depending on the quality of seed and the species. Meanwhile, the free fatty acid and quality of oil depend on the weather prevailing during the time that cotton stands in the fields after coming to maturity. Hence, the quality of oil varies from place to place and season to season. In more specific, the quality of oil is high in dry seasons and low when the seed is exposed to wet weather in the fields or handled or stored with high moisture. Crude

cottonseed oil has a better condition stability due to the presence of segment named gossypol (Bambawale *et al.*, 2004).

Cottonseed oil must be refined to remove gossypol, a naturally occurring toxin that protects the cotton plant from insect damage (Kanoi, 2005). Therefore, unrefined cottonseed oil is sometimes used as a pesticide. The oil with practically no gossypol is pale yellow in colour and rich in Vitamin-E and can be used directly as a cooking medium, as well as for manufacturing of vanaspati. The keeping quality of oil is also quite good and is comparable with other edible oil (Alderks, 1948).

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### COTTONSEED OIL PRODUCTION SCENARIO IN INDIA

The total production of cottonseed oil (Washed) in India, i.e. both from undecorticated crushing and scientific processing, was estimated to be 851,000 tonnes during the period between November 2008 and October 2009 as compared to 934,000 tonnes between 2007 and 2008. It clearly revealed that cottonseed oil production was lagging behind the estimated potentiality of 1.17 million tonnes during 2008-09 as against 1.29 million tonnes during 2007-08, if all cottonseed available for processing was scientifically processed. Of course, this is due to huge amount of cottonseed is being crushed through traditional methods in India (Tripp & Pal, 2000). As per an estimate, about 9 million tonnes of cottonseed produced in India could yield approximately 1.5 million tonnes of oil (Irani *et al.*, 2000). The nutritional value of cottonseed oil is around 9 kcal/g, while the average digestibility is around 97%, which is

comparable to that of the soybean, safflower and sunflower oil (Achaya, 1990).

As of 2008, oilseed was grown on 26.54 million hectares and produced 28.82 million tonnes, with an average productivity of 1086 kgs/ha. The net domestic availability of edible oil was only 7.2 million tonnes as against the actual consumption of 11.5 million tonnes and the gap of 4.3 million tonnes had to be imported, and this posed a great drain on the Indian foreign exchange. It was projected that by 2020 A.D, India would have to produce 66 million tonnes of oil seeds to meet the oil demand of 21.8 million tonnes. Otherwise, India has to helplessly depend on imports (Persaud and Landes, 2006). This is a big challenge before India.

### TRADITIONAL METHOD RESULTS IN SIGNIFICANT LOSS IN THE PRODUCTION OF COTTONSEED OIL

More than 95% of the cottonseed processed in India is through traditional (crude) method,

TABLE 1  
Production of oilseed/oil and net domestic availability of edible oil in India (2002-07)

	(in 00000 metric tonnes)	
	Oilseeds	Oil
Groundnut	48.6	11.3
Rapeseed-mustard	74.4	22.0
Soybean	99.9	14.2
Sunflower	14.4	3.9
Sesame	5.8	1.8
Niger seed	0.7	0.2
Safflower	2.2	0.7
Castor	7.9	3.2
Linseed	1.8	0.5
Coconut	-	4.5
Cottonseed	-	6.3
Rice bran	-	7.0
Solvent extracted oil	-	3.5
Tree & Forest origin	-	1.2
Less: Export of industrial	-	7.8
Net domestic availability of edible oils		72.4
Import		42.2
Actual consumption		114.6

Source: AICOSCA News Letter, Mumbai, February 2009, p.4

wherein the seeds are simply crushed through mechanical means without undergoing the pre-process formalities of delinting or dehulling, etc. (Barwale *et al.*, 1999). The process is rather primitive in nature and yields only about 12-13% crude oil, which is inferior in term of quality and dark in colour. Moreover, it produces about 80-85% cake which has low nitrogen and high fibre content (Jayaraman, 2004). The process also results in passing of about 6 to 7% oil in oilcake, which is considered as a waste. It is a myth that oil content in the cottonseed cake raises milk yield or fat percentage in the milk. In addition, oil is generally required to generate energy. The energy is generated while cattle carry on rumination of the fibrous portion of the feed. The ruminant have a specialized digestive system with compound four compartment stomach. Therefore, the oil content in oilcake is virtually not of much use to the cattle (Santhanam and Sundaram, 1999). There is a loss around 500,000 to 600,000 tonnes of cottonseed oil every year due to the practice of undecorticated cottonseed cake feeding to the cattle (Bhale, 1999).

### FAT FACTOR

Cooking oil is pure fat obtained from plants or animals. Whether from plants or animals, one gram of cooking oil or fat provides about nine calories. Experts recommend a total of 20 gm or four teaspoons of oil for an adult. The type of oil being consumed determines a person's risk of heart disease. All cooking oil is made up of a combination of fatty acids, which may be saturated, mono-unsaturated or poly-unsaturated. Their relative proportions classify the oil as saturated, mono-unsaturated or poly-unsaturated (Dohlman *et al.*, 2003).

Saturated fat found in animal fat like ghee, butter, lard (fat in meat) is solid at room temperature and raises LDL (bad) cholesterol in blood (Tomek and Peterson, 2001). At the same time, it reduces HDL (good) cholesterol. Good for infants and young children, the fat is a definite no-no for heart health. Plant oils like palm oil (palmolein) and coconut oil are also

very high in saturated fats and should be totally avoided (Cheng Hai, 2002).

On the other hand, both Mono-Unsaturated Fatty Acids (MUFA) and Poly-Unsaturated Fatty Acids (PUFA) are considered 'good' fat because they lower total LDL cholesterol. Ideal cooking oil requires a balance between MUFA and PUFA levels. Also, since omega-3 fatty acids are extremely good for the heart, selecting an oil rich in omega-3s is therefore important. Thus, which oil is good for cooking?

Mustard oil, canola (rapeseed) oil, olive oil and groundnut oil have the best combination of good and bad fatty acids. Meanwhile, gingelly oil is another excellent option. Soybean, corn, sunflower and safflower oils have low saturated fatty acid contents, but their MUFA content is lower than the PUFA content, which is not desirable.

Since time immemorial, mustard oil is used in India and recent research lauds mustard oil as ideal. A study by the Harvard School of Medicine, All India Institute of Medical Sciences, New Delhi, and St. John Hospital, Bangalore, found that chances of heart disease drop by nearly 70 per cent when mustard oil is used for cooking (World Bank, 1997). Moreover, its nutritional benefits are comparably better with the much-hyped olive oil at one-sixth the cost. Cooking in mustard oil (especially the cold-pressed or Kachchi ghani variety) could be the wisest health investment one can make.

Cottonseed oil contains about 50% essential poly-unsaturated fatty acid (linoleic acid) against about 30% in the traditional oil, which is required in human diet as it is not biosynthesized in human body and prevents coronary arteries from hardening. It is safe and suitable for human consumption. It is one of the few oil types which are in the "OK FOOD" list of American Heart Association (AHA) and considered as "Heart Oil". The oil is nutritive as certified by AHA. As stated earlier, cottonseed oil has high level of natural antioxidants. These antioxidants make cottonseed oil a natural preservative that contribute long fry life and shelf life for many different food sources.

Cottonseed oil is moderately rich in MUFA and PUFA and it is also an ideal cooking medium. An alternative product from refinery is a partially processed cottonseed oil and sold as Washed Oil. It is ideal oil in the manufacture of margarine (Butter substitute) and bakery products.

Another advantage is that it does not allow speedy blackening of coronary arteries by forming hard pellets of cholesterol. In view of the above, cottonseed oil should be made mandatory to be used in the form of blend, either with oil or with hydrogenated vanaspati. It can also be supplied in the form of encapsulated material.

The fatty acids are essential for synthesis of various hormones, without which, the internal vital organs of the human body cannot function properly. The fatty acid profile of various edible oil types is given in Table 2.

#### **WHY IS THE COTTONSEED OIL HIGHLY ACCEPTABLE AS AN EDIBLE OIL?**

Even though cottonseed oil is darker than soybean, peanut and other traditional oil types in colour, the impurities and pigments are readily removed by modern refining and bleaching techniques to produce lighter colour. It possesses properties that make it suitable for processing in salad oil. The proportion of highly saturated glycerides is such that when the oil is chilled slowly, the higher melting glycerides separate out and can be readily removed by filtration which does not get crystallized when held at 40° to 45°F. The high melting portion is generally utilized in blended oils for shortening or in hydrogenated products. It contains traces of fatty acids with instauration greater than linoleic acid. On hydrogenation, the instauration decreases and stability is further increased. Unlike soybean oil, cottonseed oil has greater resistance to flavour reversion. The stability is also due to the presence of antioxidants, namely tocopherols (Srinivasan, 2004).

#### **TO FRY IN**

The oil is primarily used as a medium for frying and for manufacturing of hydrogenated vegetable products, cooking, and salad dressings and production of soap. Now, which oil is the best for frying? The high heat during frying decomposes or breaks down the oil producing cancerous substances. So, the best oil for frying is one that can withstand the high temperature without foaming and smoking. Groundnut and gingelly oil are especially good for frying.

All said and done, the best bet is to use a variety of oils judiciously. A combination of several oil types ensures a healthy intake of all important fatty acids. It may also wise to rotate the good oil types over the months. Thus, use mustard, sesame, canola or olive oil (extra light or refined) for cooking, groundnut oil for frying, and olive oil (extra virgin) for salads and pasta. As for cooking oil, less is more.

Speaking of fats, one should not ignore the latest demon on the health scene, i.e. trans fats or vegetable oil that have been partially hydrogenated. Meanwhile, food manufacturers add hydrogen to liquid vegetable oil and heat them. As a result, the oil is hardened and the shelf life is increased. Food made with such partially hydrogenated fat has better texture, flavour, taste and spreadability.

Cottonseed oil is commonly used in manufacturing potato chips and other snack food. Along with soybean oil, it is very often partially or fully hydrogenated. The growing consensus is that in hydrogenated (trans fats) form, these oil types are very unhealthy. Cottonseed oil was the first oil to be hydrogenated in mass production, originally intended for candle production, and also as a food. In part because regulations apply differently to non-food crops, it has also been suggested that cottonseed oil may be highly contaminated with pesticide residues; however, insufficient testing has been done to prove this. Cotton (oil) is also one of the big four (soy, corn, rapeseed/canola, and cotton) genetically modified crops grown around the world. Fried foods and fast food chains commonly use cottonseed oil and vegetable oil blends to fry everything.

TABLE 2  
Fatty acid composition of various edible oil

Oil source	Fatty acids (%)						
	Myristic (14:0)	Palmitic (16:0)	Stearic (18:0)	Others	Oleic (18:1)	Linoleic (18:2)	Linolenic (18:3)
Cottonseed	0.79	24.70	2.20	-	20.87	50.76	-
Groundnut	-	13.69	1.96	3.28*	52.13	28.94	-
Sunflower	0.38	4.27	5.46	-	49.41	40.48	-
Safflower	1.50	3.00	1.00	-	33.50	61.00	-
Til	-	10.02	5.85	-	40.11	44.02	-
Soybean	-	10.33	3.86	-	26.52	52.92	6.37
Corn	-	14.98	1.31	-	34.12	49.59	-
Mustard	-	2.10	0.39	3.010*	10.31	13.80	11.52
Coconut	18.76	8.38	2.18	62.17*	6.96	1.55	-
Palm	1.50	45.00	4.00	-	39.00	10.50	-

\* This includes caproic, caprylic, capric, lauric, arachidic, dehenic and lignoceric, either all or a few in different properties:

Palmitoleic (16:1)	Cottonseed 0.68%	Mustard 0.26%
Elcosenoic (20:1)	Mustard 7.39%	
Decosenoic (22:1)	Mustard 51.2%	

Source: AICOSCA News Letter, Mumbai, June 2008

### WHY IS TRANS FAT BAD?

The processed food industry loves trans fats (Pray *et al.*, 2001). One can find it in biscuits, crackers, cookies, breads and buns, breakfast cereals, bread spreads and salad dressings, cakes and cake mixes, microwave popcorn, pizza, burgers and French fries, heat-and-eat curries, artificial creamers, chocolates and candy, mithai and ice cream.

If trans fat makes food so tasty, why are they bad? Trans fat fouls up the body's entire machinery, and it causes weight gain and excessive abdominal fat – both risk factors for heart disease and diabetes. Moreover, it increases LDL cholesterol, which clogs up arteries, and lowers the HDL cholesterol, which will otherwise take HDL cholesterol to the liver where it would be broken down and excreted. In fact, trans fat interferes with metabolism of fats and elevates blood triglyceride levels. If one continues to eat trans fat-rich foods, it sets the stage for a heart attack.

Ironically, there is no safe limit for trans fat. Some amounts of trans fat are found in whole

milk and meat, but this is too small an amount. Trans fat that is found naturally in animal fats is much less harmful than that found in partially hydrogenated oil.

In its natural un-hydrogenated state, like all vegetable oil, cottonseed oil has no cholesterol. It also contains no trans fatty acids. However, it contains over 50% omega-6 fatty acids and only trace amounts of omega-3 fatty acids, and the imbalance is considered unhealthy if not used in moderation or balanced elsewhere in the diet. Furthermore, this poly-unsaturated fat can potentially go rancid during the extraction process.

### THE FACTS OF COTTONSEED OIL

Cottonseed oil is extracted from cottonseed. It plays a vital role in terms of adding value than any other by-products of cottonseed. In USA, it is a part of diet for well over a century. Until the 1940's, it was the major vegetable oil produced in the United States. Now, it ranks third in volume after soybean and corn oil, representing

about 5-6% of the total domestic fat and oil supply. The average annual production crosses more than 1 billion pounds in the United States.

Cottonseed oil has many food applications. As salad oil, it is used in mayonnaise, salad dressings, sauces, and marinades. As cooking oil, it is used for frying in both commercial and home cooking. As shortening or margarine, it is ideal for baked goods and cake icings. It is primarily used in the U.S. as a salad or cooking oil. About 56% is consumed in that category, while about 36% goes into baking and frying fats, and a small amount into margarine and other uses.

Cottonseed oil has a mild, nut-like taste, clear, with a light golden colour, flavour stability and is used as a yardstick for measuring flavour and odour qualities in other oil. Meanwhile, refined and deodorized cottonseed oil is one of the purest food products available. Few food types can be as highly cleaned and refined, and still maintain their nutritional quality. Cottonseed oil meets the government's strict standards for purity. Unlike some oils, cottonseed oil does not deteriorate or "revert" rapidly in flavour when it is used at high temperatures. Owing to acceptability of reducing saturated fat intake, it is considered as one of the few unsaturated oil, like safflower, corn, soybean, canola, and sunflower seed oil.

Cottonseed oil has a 2:1 ratio of poly-unsaturated to saturated fatty acid. It is described as naturally hydrogenated because its fatty acid profile generally consists of 70% unsaturated fatty acids, including 18% mono-unsaturated (oleic) and 52% poly-unsaturated (linoleic), and 26% saturated (primarily palmitic and stearic). These make the oil stable for frying without the need for additional processing or the formation of trans fatty acids.

Cottonseed oil does not have to be as fully hydrogenated for many purposes as some of the more poly-unsaturated oil. When it is partially hydrogenated, however, its mono-unsaturated fatty acid actually increases. When hydrogenated to a typical Iodine Value of about 80, for example, its fatty acid profile shifts to

50% mono-unsaturated, 21% poly-unsaturated, and 29% saturates all well within current diet/health guidelines.

Cottonseed oil is rich in tocopherols. These natural antioxidants, which have varying degrees of vitamin-E activity, also contribute to its stability giving products that contain it a long shelf life. It can be found as an ingredient in many food products and is available on the grocery shelf only in limited areas. Cottonseed oil is light, non-oily consistency and high smoke point, making it the most desirable for stir fry cooking and other oriental dishes, as well as for frying fish.

### NEGATIVE IMPACTS OF COTTONSEED OIL

The renowned nutrition expert, Dr. Andrew Weil, says cottonseed oil contains both naturally occurring toxins and pesticide contaminants. Cottonseed oil is generally extracted by using harsh chemical solvents and heat which may alter the chemistry of the oil. Most nutritionists are still uncertain about the long-term implications of these changes. Cottonseed oil is high in Vitamin E, which is an antioxidant. Antioxidants present in cottonseed oil work against the free radicals that cause cell damage aging. Nonetheless, it has very low amounts of heart-healthy omega-3 and mono-unsaturated fats.

In addition, cottonseed oil contains gossypol, a substance that has been shown to cause sterility in rats. For this reason, it has been used in parts of the world as a contraceptive and cottonseed oil has been seen as a threat to men's fertility. A 2006 study done at the University of Lecce, Italy, "proteinaceous diet inhibits gossypol-induced spermatotoxicity" showed that gossypol in cottonseed oil is not an effective contraceptive, because if combined with most proteins, gossypol no longer causes infertility. Gossypol still has toxins that decrease spermatogenesis and sperm motility in men. This is a topic that should be brought up with fertility doctors because cottonseed oil is a very commonly used ingredient in many foods.

### COTTONSEED OIL: INDIAN PERSPECTIVE

The survey has confirmed that cottonseed oil is a significant source of income for the community in the main cotton producing districts of India and that within the local market cottonseed is valued for cooking oil. In terms of gender, cotton is a crop which is almost exclusively the domain of women. The crop is gathered by women and children and processed by them. Cottonseed oil is enshrined in the domestic culture of women and is used as source of edible oil which has less fatty contents and good for health. Men are mainly involved in the storing and marketing of cottonseed oil (Sharma, 2006). Research has found that the high involvement of women in purchasing and consumption of cottonseed oil is likely to be the most lucrative commercial activity of the oil market. Therefore, any increase in demand for cottonseed oil would have a considerable positive economic impact on their livelihoods.

For dietary and food security importance, cottonseed oil is highly prized as health oil during the lean season and is an important source of fat for most of the villages in the northern districts. Thus, cottonseed oil is one of the best sources of cooking oil.

### WHOLESOME TIPS

The maxim 'Health is Wealth' advocates that people are health conscious and subjected to follow certain tips to keep their health in good condition. As a general rule, cook wholesome meals at home with healthy oils. When shopping, avoid food that contains shortening, hydrogenated or partially hydrogenated oil as an ingredient. Since it is now mandatory to put trans fats content on the label, choose food with no trans fat. At the same time, avoid eating at roadside dhabas, takeaways, and halwais. Restrict eating out to once a month. Avoid gravies, creamy sauces, and salad dressings. Opt for stir-fried over fried and grilled over curried.

### CONCLUSIONS

The utilization of cottonseed oil for human consumption should receive immediate attention in India for meeting the shortage of edible oil (Mehta, 2006). It contains more than 50% of poly-unsaturated fatty acids and is very ideal in human diets. Cottonseed oil is very popular in USA (Young and Westcott, 2000). However, in India, it is used to a very small extent. Therefore, efforts are to be made on a war footing to popularize its use in our country, which can eventually result in stoppage of import of other edible oil, at least to some extent. Efforts are also needed to popularize cultivation of varieties of cotton with high percentage of oil. Nonetheless, most of the people need to curb the total amount of fat in their diet (Morris, 2002). A combination of oil ensures a healthy intake of all important fatty acids. Therefore, use mustard, sesame, canola or olive oil (extra light or refined) for cooking, groundnut oil for frying, and olive oil (extra virgin) for salads and pasta. With cooking oil, less is more.

### REFERENCES

- Achaya, K.T. (1990). *Oilseeds and Oilmilling in India: A Cultural and Historical Survey*. New Delhi, India: Oxford and IBH.
- AICOSCA. (2005-2009). News Letters and Annual Reports for 2005-2009, All India Cottonseed Crushers' Association, Mumbai.
- Alderks, O.K. (1948). Cooking of meats and recovery of the oil. In A.E. Bailey (Ed.), *Cottonseed and cottonseed products: Their chemistry and chemical technology* (pp. 615-650). New York: Interscience Publishers.
- Bambawale, O.M., Singh, A., Sharma, O.P., Bhosle, B.B., Lavekar, R.C., Dhandapani, A., Kanwar, V., Tanwar, R.K., Rathod, K.S., Patange, N.R. and Pawar, V.M. (2004). Performance of Bt cotton (MECH-162) under Integrated Pest Management in farmers' participatory field trial in Nanded district, Central India. *Current Science*, 86(12), 1628- 1633.
- Barwale, R.B., Mukherjee, S.K. and Gadwal, V.R. (1999). *Handbook of Cotton in India*

- 1999, Transgenic Cotton and Biotechnological Approaches in Cotton Improvement Research.
- Bhale, N.L. (1999). Heterosis breeding in cotton. Handbook of Cotton in India, Indian Society for Cotton Improvement, Mumbai.
- Cheng Hai, T. (2002). A Report on Palm Oil Supply Chain, Plantation Agriculture, WWF Malaysia, Malaysia.
- Dohlman, E., Persaud, S. and Landes, R. (2003). India's edible oil sector: Imports fill rising demand, OCS-0903-01, Electronic Outlook Report from the Economic Research Service, USDA.
- Francis Kanoi. (2005). Agri-Inputs Marketing Research, *Cotton Crop Track, 2004-2005, A Report on Seeds*, Chennai.
- Hindustan Lever, Economic Department. A Projection of India's Demand for Fats and Oils in the Future Five Year Plans – Up to 1976 (Calcutta, 1972).
- Irani, S.A., Zhang, H., Zhou, J., Huang, H., Udai, T.K. and Subramanian, S. (2000). Production flow analysis and simplification toolkit (PFAST). *International Journal of Production Research*, 38(8), 1855-74.
- Jayaraman, K.S. (2004). India produces homegrown GM cotton. *Nature Biotechnology*, 22(3), 255-56.
- Mehta, B.V. (2006). Overview of the Indian oilseed sector and demand of edible oils. *Proceedings of Exchange Traded Commodities Outlook 2005-06* (organized by Foretell Business Solution Private Ltd).
- Morris, M.L. (2002). The development of the seed industry under globalization. In D. Bigman (Ed.), *Globalization and the developing countries: Emerging strategies for rural development and poverty alleviation*. CABI Publishing in association with ISNAR, Wallingford, U.K.
- Persaud, S. and Landes, M.R. (2006). The role of policy and industry structure in India's oilseed markets. Policy and Industry Structure in India's Oilseed Markets/ERR-17, Economic Research Service/USDA (2005-2006).
- Pray, C.E. Bharat Ramaswami and Kelley, T. (2001). The impact of economic reforms on R&D by the Indian seed industry. *Food Policy*, 26(6), 587-598.
- Santhanam, V. and Sundaram, V. (1999). Historical Perspective of Cotton in India, Handbook of Cotton in India, Indian Society for Cotton Improvement, Mumbai.
- Sharma, A.R. (2006). Production, availability & technological advances in vegetable oil industry. *Sea News Circular*, 3(4).
- Srinivasan, C.S. (2004). Plant variety protection in developing countries: A view from the private seed industry in India. *Journal of New Seeds*, 6(1), 67-89.
- Tomek, W.G. and Peterson, H.H. (2001). Risk management in agricultural markets: A review. *The Journal of Futures Markets*, 21(10), 953-985.
- Tripp, R. and Pal, S. (2000). Information and agricultural input markets: Pearl millet seed in Rajasthan. *Journal of International Development*, 12, 133-144.
- World Bank. (1997). The Indian Oilseed Complex: Capturing Market Opportunities, July 1997, World Bank, Washington D.C.
- Young, C.E., and Westcott, P.C. (2000). How decoupled is U.S. agricultural support for major crops? *American Journal of Agricultural Economics*, 82, 762-767.