International Journal of Econometrics and Financial Management, 2014, Vol. 2, No. 4, 130-135
Available online at http://pubs.sciepub.com/ijefm/2/4/3
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DOI:10.12691/ijefm-2-4-3

Development of Agro-industrial Clusters in Russia: Synergetic Approach

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Received July 30, 2014; Revised August 17, 2014; Accepted August 25, 2014

Abstract Based on the analysis of objective statistical data authors identified a global megatrend of the XXI century and the related growth of knowledge-intensive clustering, which provides high efficiency and competitiveness of the world economy. Based on the study of synergy, the self-organization theory and the eastern philosophy on original principles of synergy, the synergetic approach to the cluster development is elaborated. Article shows an artificial and rapid creation and development of clusters that uses the achievements of synergy, in particular ultrafast processes of the hyperbolic growth. The proposed model of clustering considers these processes.

Keywords: *Knowledge-intensive growth, clustering, competitiveness, self-organizing clusters, agro-industrial clusters*

Cite This Article: Huhrin A.S., Bundina O.I., Agnaeva I.Yu., and Tolmacheva N.P., "Development of Agro-industrial Clusters in Russia: Synergetic Approach." *International Journal of Econometrics and Financial Management: Special Issue on Geography of Innovation and Economic Clusters: Evidence from Russia*, vol. 2, no. 4 (2014): 130-135. doi: 10.12691/ijefm-2-4-3.

1. Introduction

Clustering in the Russian Federation has acquired an all-embracing nature. Clusters are being formed and developed in the majority of Russian regions. The existence of 25 regional innovative clusters is officially recognized by the state. While additional 27 agro-industrial clusters and seven clusters of food processing industry are being formed.

The formation of clusters conceals an enormous economic development potential for the whole of Russia, which is clearly evident from Table 1. The main feature of the chosen approach to the data representation is objectivity of the information used. The data is acuired from independent sources [1,2,3] and is being interpreted strictly on a logical basis, based on the figures. Any reader can easily verify the reliability and validity of conclusions made. The table includes primarily 10 countries with the maximum amount of public expenditure on R&D and education (as % of GDP), which are ranked according to their valume. For comparison reasons, Table 1 also includes data on Russia, China and India, as the largest and most dynamic world economies. Thus, the indicators in Table 1 are formed purposefully and without bias.

Analysis of the data in Table 1 shows that the list of countries formed by the specified criteria, includes countries, ranked the first 24 places (i.e. 1, 2, 4, 5, 9, 12, 20, 21 and 24) in the world competitiveness ranking in 2013. These countries are the United States (1st), Switzerland (2nd), Sweden (4th), Singapore (5th), Germany (9th), and Denmark (12th). Performance indicators suggest that the most efficient economy of the world is in the United States.

This fact can be partly explained based on the data from Table 1. Although the United States spend only 8.2% of the GDP on research and education, in absolute term this value is the largest, especially on R&D (more than one third of the world expenses). In addition, the United States has the maximum number of clusters – 380 units. Efficiency of the economy of Denmark, which has, in our opinion, the most balanced and maximum relative expenditure on R&D and education, is combined with an almost complete clustering of the national economy. Denmark in 2011 had a maximum level of GNI per capita.

Therefore, analysis of the data shows that the higher the public expenditure on R&D and education is, as well as the level of clustering of the economy, the higher is the level of competitiveness and efficiency of the economy. Of course, the level of competitiveness and efficiency of the world's economies is additionally influenced by other factors, but the factors that we named "research intensity and clustering" are the basic driver of economic development in the XXI century. Growth of R&D intensity and clustering are interconnected. Increase in the values of these indicators is consuggested to be the global megatrend of the XXI century. Thus, the country that gives weighted preference to the development of R&D within the formation of clusters will have the most dynamic development.

Given the objectivity of this global megatrend, Russia cannot ignore the mainstream of economic development of the XXI century. The country has a 'young' and unestablished disharmonious market economy. Russia does not have 100 years and nor it has 40 years waiting

time for the natural development of the economy, and clusters in particular. Russia should choose and use the most rational, efficient, and withal a super-fast way (i.e. process) to achieve the goal (a hyperbolic growth). In other words, we propose to develop the economy and clusters by using a synergistic approach. Let us laconically consider the essence of this statement.

Table 1. Impact of R&D intensity and clustering on the competitiveness and efficiency of the economies of a number of countries in the world

Indicators / Countries	public expenditure (in % of GDP) in 2005-2010			R&D expenditure 2009	Number of clusters	Innovativeness Index rating 2012	Knowledge Economy Index rating 2012	World competitiveness index rating 2013	Share of agricultural exports 2010	The effectiveness of the world's economies (% in world's GDP / % in of world's population)				GNI per capita, $ rating 2010
	Total	on education	on R&D							2000	2005	2010	2020	
Denmark	11,7	8,7	3,0	…	34	7	3	12	21,3	3,78 /80,9	3,33 /75,5	3,25 /74,2	2,62 /65,5	59050/10
Sweden	10,9	7,3	3,6	…	…	2	1	4	8,8	3,33 /71,3	3,29 /74,6	2,86 /65,3	2,67 /66,8	50110/13
Finland	10,6	6,8	3,8	0,8	9	4	2	20	8,5	3,22 /69,0	3,38 /76,6	3,00 /68,5	2,86 /71,5	47720/16
Switzerland	8,4	5,4	3,0	…	…	1	10	2	4,1	4,00 /85,6	3,50 /79,4	3,18 /72,6	2,70 /67,5	71530/7
Republic of Korea	8,4	5,0	3,4	3,1	…	21	29	22	2,0	2,1 /45,0	2,29 /51,9	2,39 /54,6	2,64 /66,0	19890/45
Austria	8,3	5,5	2,7	…	…	22	17	23	8,7	3,39 /72,6	3,00 /68,0	2,64 /60,3	2,11 /52,0	47060/18
USA	8,2	5,4	2,8	34,1	380	10	12	1	12,3	4,67 /100	4,41 /100	4,38 /100	4,00 /100	47390/17
Germany	7,4	4,6	2,8	7,9	32	15	8	9	6,0	3,43 /73,4	3,05 /69,2	2,84 /64,9	2,53 /63,2	43110/24
Japan	7,2	3,8	3,4	14,0	…	25	22	24	1,3	3,49 /74,7	3,21 /72,8	3,02 /69,0	2,66 /66,5	41850/27
Singapore	6,0	3,3	2,7	…	…	3	23	5	2,2	3,00 /64,2	3,00 /68,0	2,86 /65,3	3,08 /77,0	40070/29
Russia	5,4	4,1	1,3	1,4	25	51	55	48	4,1	0,96 /20,6	1,15 /26,1	1,33 /30,4	1,68 /42,0	9900/67
China	…	…	1,5	4,4	66	34	84	21	3,3	0,53 /11,4	0,70 /15,8	0,88 /20,1	1,20 /2,6	4270/107
India	3,9	3,1	0,8	0,9	106	64	110	40	10,5	0,33 /7,1	0,36 /8,2	0,40 /9,1	0,47 /11,8	1330/146

2. The Cluster and the Synergy

Clusters are self-organizing forms of integration. It is generally recognized that the most effective clusters are formed naturally as a result of self-organization, for example, Silicon Valley, California wine cluster in the United States and others. Consequently, it is logical to consider the clusters as complex self-organizing systems and explore them in terms of synergy (i.e. the theory of self-organization). In our opinion, synergy is not only a new paradigm of development of agro-industrial clusters, but also the clusters in general. Especially since an original scientific direction of synergy is founded and in being developed Russia. This direction of synergy created by the outstanding Russian scientist Sergei Pavlovich Kurdyumov.

Namely, Kurdyumov has studied ultrafast processes in a hyperbolic growth [4,5]. Synergetics investigates the mechanisms of self-organizing systems of a quite different nature, as it would seem (i.e. open and non-linear; starting with physics to sociology, and a private individual). Conclusions and recommendations of synergetics are based on the results of computational experiments and a number of rigorous mathematical results that are obtained for relatively simple models of open nonlinear environ. Development of non-linear mathematics, primarily based on the generalization of the results of computer calculations of mathematical models in different fields of science, it has become a source of new ideas and new paradoxical philosophical representations. It is appropriate to recall the words of a prominent scientist, the founder of tectology A.A. Bogdanov: "Is it permissible that the same laws to be applicable to combinations of astronomical worlds and biological cells, living people and ethereal waves, scientific ideas and atomic energy? ... Mathematics provides a strong and irrefutable answer: yes" [6].

In 2003, S.P. Kurdiumov spoke at a conference in Suzdal to the humanities with a report on the symbolic theme "Acupuncture of the world" [4]. It has a great heuristic value, in which he not only revealed the essence of synergy in an accessible language, but also inadvertently pointed out the connection of synergy with certain synergistic anticipations of Chinese philosophy and strategy. Paradoxically, some of their achievements in synergy (e.g. proliferation of small) rediscovered the extreme efficiency of small resonant effects [4]. At the same time, special attention deserves such traditional Chinese concepts on strategy as 'potential of a situation', 'adherence to the circumstances', and 'non-action' [7,8]. It seems to us that the heuristic synthesis and application of these concepts and theories will freshen the view of the opportunities and drivers for the development of clusters in the Russian Federation. Kurdiumov ended his brilliant performance in 2003 in Suzdal with the words: "No need to wait with bowed head for a new global catastrophe, but it is necessary to simulate a different path of development of the world". To paraphrase, this brilliant idea, we could state the following: "Do not expect that someone abroad, for example, Michael Porter develops new organizational principles for the development of clusters for us. We need to simulate our own original Russian way of cluster development, which would be appropriate to our context".

The need for a synergistic approach for the development of clusters is due to several reasons: clusters

as real systems are open and non-linear; there is a similarity between the cluster and synergistic approaches; effective clusters organize themselves over a long period (10-30 years or more); the global systemic crisis. Let us explain the least obvious reasons: the second, third and fourth.

Cluster and synergetic approach are similar: the first, on the one hand, it not focuses on systemic issues of macroeconomic level, and on the other – not aimed at the study of individual organizations. In other words, the cluster approach involves research on organizational linkages, which tend to form a network. Synergetic approach has a similar unit of description as a set of objects, a network, properties are studied in ensembles, a set of objects, and not of individual units.

The world practice, primarily the experience of the United States, has shown that effective clusters organize themselves for a long time (more than 10 years), which is unacceptable for the Russian economy, for its agriculture under the conditions of WTO. If Russia is at a pace to create effective clusters, in 10 years time it may suffer huge economic losses. As the global competition consists not of individual firms and even TNCs, but clusters. Effective clusters should be created in 2-3 years, of course on a different basis, using new technologies and organizational principles.

The ultimate reason of a global scale that encourages to use synergetic approach is that currently there is a systemic global crisis, which manifests itself in many ways, particularly in the economic, environmental, as a consequence of the fact that mankind is completing its hyperbolic growth [4,5]. In order to reduce in part the relief of this crisis, it is necessary to carry out the clustering of the world's economies, including Russia, which will contribute to the sustainable development of the 'world – system'.

It should be noted that earlier in the debate on clusters in the journal "Economics of agricultural and processing enterprises" was published a number of scientific papers related to the systemic – synergistic approach and hyperbolic growth [9,10,11,12]. However, these studies have pointed to the need for a synergistic approach, the use of hyperbolic growth processes, but did not answer the question: "How to do it?". This publication addresses these issues in detail and constructively. Table 2 presents the basic idea of using the synergy in the development of clusters, its basic concepts, features and fundamental characteristics.

Table 2. Synergetics applied to the development of clusters

Idea	Concepts	Features synergistic approach	Fundamental characteristics
• Targeted self-organization of clusters; • The development of agro-industrial clusters as co-evolution of their participants; • Cluster management using small resonance effects; • Accelerating the development of effective clusters for 2-3 years.	• Self-organization; • Openness; • Linearity; • Instability; • Dissipativity; • Small resonance effects; • Attractor; • Critical Mass; • Ultrafast processes of hyperbolic growth; • Positive Feedback; • Co-evolution; • Metastability; • Potential the situation.	• development polyvariety; • 'The growth of small'; • 'Narrow development corridor' – a quantum effect; • Emergence; • Synergistic anticipations of ancient China; - The potential of the situation; - Inaction; - Following circumstances.	• Self-organization; • Openness; • Linearity; • hyperbolic growth; • Situational potential.

The first idea suggests that by using the achievement of synergy one can purposefully create effective clusters. In terms of synergy this idea can be revealed as follows: first of all, to form a cluster of optimal structure the interests, benefits, factors and trends, contradictions, obstacles in its development must be identified. Further, based on their analysis and evaluation, small resonant efforts should be applied to cluster to help create a target structure. Cluster organizes itself very quickly if the benefits of joining the cluster for potential participants are significant and obvious. In this case, cluster members will join the cluster at their own will.

The second idea of synergy in relation to clusters is the need to achieve sustainable development through the implementation of interconnected coevolution of clusters' participants. For this purpose, in addition to traditional measures – development of a strategy for clusters, new organizational principles of the formation and development of clusters should be created and implemented in practice.

Next idea of using synergy in the development of clusters is to manage small resonance effects, which are based on accounting benefits derived by participants from joining a cluster. Clusters are self-organizing organizations, which are joined by the participants in a desire to receive certain benefits. The concept of 'benefit' is subject to 'everything', including the development of a strategy and tactics of clusters. But the 'benefit' is not only an 'objective', but also an 'instrument'. Clusters are joined for profit gains. Profiting forms the goal of the cluster members. Therefore, managing the objective – benefits of the participants, one can control their actions and cluster as a whole.

It is possible to manage individual cluster members, the cluster as a whole, and its development by using small resonant effects. For this, cluster members need to be given the precise real benefits or losses they might get from joining the cluster or from other individual actions. Based on a deeper understanding of the situation, the manager or the head of a cluster can inform cluster participants on the benefits or losses from their actions, thus do a 'soft' guidance of their behavior. The early presented information will resonate with an already available information about the benefits and losses, and encourages them to act in the right direction.

The latter idea is to accelerate the development of effective clusters, reducing the period to 2-3 years instead of 10-30 years or more. This may be done, first of all, by the implementation of the first three ideas, as well as the use of new organizational principles and ultrafast processes of hyperbolic growth. In contrast to the naturally occurring clusters, engeneered cluster is created on the

basis of innovative technologies, the use of which contributes to the rapid integration of potential cluster members.

Basic concepts of synergy in relation to the development of clusters are shown in Table 3. It should be noted that the novelty of this conceptual apparatus is the inclusion of a complex and sophisticated concepts of traditional Chinese strategy of 'situational potential' (i.e. SHI) [7,8]. It is our deep conviction that the introduction, comprehension and application of this conceptual understanding of clusters may increase the efficiency of cluster governance.

The third column of the Table 2 shows the main features of the synergetic approach. We shall further explain the most important ones.

Polyalternativeness of cluster development. Nowadays it is recognized, that the most effective clusters emerge and organize themselves in a 'natural' way. A 'natural' way is an unintentional self-organization of clusters, nevertheless based on active meaningful human activities, their arbitrary decisions. At the same cluster (latent, potential) is created spontaneously, unintentionally, without knowing, what the end result would be. If the cluster is to create intentionally, which according to Marx differs a human being from bees, the effective cluster can be created in a shorter time and without errors of spontaneity. In terms of synergy not only natural way of cluster formation is real, but also an artificial – purposeful creation of effective clusters seems to be more rational and plausible, especially in terms of rapid scientific and technological progress. Moreover, the principal characteristic of the 'cluster' phenomenon, as shown by this study, is the presence of a unique competitive advantage due to location and the use of innovative technologies.

It is paradoxical and surprising that in ancient China, philosophers to some extent anticipated the opening of synergy. The latter makes it even more compelling. Moreover, some of the achievements of Chinese philosophy and art of strategy in a synergistic sense remain inaccessible because of their depth of penetration into the essence of reality. Such as the concept of a 'situational potential'. It is denoted by the term 'Shi', which is extremely difficult to translate and roughly translates as 'the force of circumstances'. Situational potential (i.e. SHI) identifies conditions or some aggregate force of events (i.e. of cluster formation) [7,8].

A famous sinologist V.V. Maljavin defines the situational potential (i.e. 'Shi') as a kind of cumulative life force flow, dynamic configuration of forces created by the game all the circumstances 'of the moment' [7].

Table 3 shows the definition of situational potential from the point of view of synergetics. Necessity to introduce this term in the scientific context and its practical application in the formation of clusters is due to the fact that synergetics does not have a term that would characterize the results of the joint, collective interaction of all factors, or 'game' of all the circumstances of the situation, which are surrounding the cluster creation. In this case, at the heart of the 'situational potential' is placed a fundamentally important socio-economic category – the 'benefit'. It socializes authors' vision of the synergetic approach to the development of clusters.

Table 3. Basic concepts of synergy in relation to the development of agro-industrial clusters

Characteristics	Description of characteristics
Self-organization	Processes of spontaneous ordering (the transition from chaos to order), the formation and evolution of structures in open nonlinear environ.
Non-linearity	Multiple routes of evolution, a choice of alternative routes and a certain tempo of evolution, as well as the irreversibility of evolutionary processes, ultrafast processes in a regime with peaking.
Openness	An open system (environ) – a certain kind of systems (environs), which exchange the matter, energy and information with the environment, i.e. have multiple sources and sinks in each point of the system.
Instability	Near the time of hyperbolic growth – the sensitivity of the stationary (evolving) structures to small perturbations (fluctuations) in the asymptotic stage, near the final' state, leading to a probabilistic chaotic disintegration of these structures; modes of ultrafast rise, development processes with non-linear positive feedback.
Ultrafast processes in a hyperbolic growth	Hyperbolic growth – a regime, which has a long quasi-stationary stage and the stage of growth of ultrafast processes in open nonlinear environ. An exacerbation (i.e. the hyperbolic growth) is a final (limited) period of time during which the process develops super-fast and asymptotically.
Small resonance effects	Resonant excitation – correspondence of a spatial configuration of the external impact to internal structures and open nonlinear environ
Co-evolution of complex systems	Interconnected development of several complex systems.
Structure-cluster	A process localized in certain areas of environ, with a specific geometric shape and the ability to develop, evolve in the environ or able to be transferred within an environ while retaning its shape.
Positive Feedback	A mechanism of itself affecting, self-unfolding processes acting at each point of an open nonlinear environ; in other words, the mechanism of an accelerated self-development, the growth of processes throughout the space of environment. This kind of mechanism is the basis of hyperbolic growth.
Dissipation	Scattering processes, erosion of a cluster.
Fluctuation	Random deviations of instantaneous values from their average values, the rate of chaoticness of processes at the micro-level of the system.
Critical mass	The minimum number of elements of a complex system, in which the implementation of a chain reaction of interactions, leap in the development, and changes is possible.
Metastability	The state of a system, the stability of which is maintained at not moderate perturbations.
Situational potential	Firstly, the potential or accumulated, unmanifested power, force, and energy; secondly, the real development of the situation, which arises as a synergistic effect of the interaction of all of its factors.

Non-linearity (Table 2) is a fundamental characteristic of reality, synergy conjugated with ultrafast processes in a hyperbolic growth, which is reasonable to use for the construction of clusters and to improve their efficiency. The non-linearity refers to an unusual reaction to external stimuli, when the 'right' effect has a greater impact on the evolution of systems, such as clusters, than that of the more powerful, but not adequately organized relative to their own trends [4,5].

Summarizing the results of the research of synergy and eastern worldview, authors propose the following set of principles of a synergetic approach to the development of clusters:

• Clusters are considered to be highly complex, open, non-linear systems, with all their properties and principles of development. The main thing is the account of self-organizing mechanisms, including chaos, treated as a constructive mechanism of self-organization, giving clusters the opportunity to enter their own trend of development as a tool of clusters' self-complition up to the optimal structure.

• Clusters should be investigated in their development.

• There are always several ways to develop real systems (i.e. clusters), its irreversibility and alternativeness in perspective and retrospective.

• There may be a number of dead-end development paths of clusters.

• The present of cluster is determined by their past and future.

• Small causes can generate huge consequences. Under certain conditions (e.g. instability) of the small effects, causes (i.e. mikro-fluctuations) can break through to the macro-level and determine makro-picture of the evolutionary process of clusters' development. Small effects can create clusters.

• At certain stages of clusters' development, an ultrafast development of processes in a hyperbolic growth is possible. The mechanism of such a development is non-linear positive feedback. Hyperbolic growth can lead (under certain conditions) to localization, to the formation of non-stationary dissipative structures (i.e. clusters).

• Hyperbolic growth are regimes of growth, when the characteristic values repeatedly increase up to infinity in a finite time. Hyperbolic growth have a number of stages that significantly differ. A long metastable stage, when all the characteristics of the processes are growing very slowly and marginally; and a stage of the asymptotic instability near the the moment of peaking, when there is a threat of decay of a complex structure (i.e. clusters).

• A complex organization (i.e. cluster), is rather metastable. In order to maintain its integrity and to periodically overcome the tendency of stochastic decomposition, it must exist in the vibrational mode, which allows slowing processes and restoring the overall pace of development of the substructures within a complex structure (i.e. cluster). The fundamental principle of the behavior of complex systems – a periodic alternation of stages of evolution and involution, expansion and invertion.

• Not any structure (i.e. cluster) can can be implemented in this environment, but only a certain subset of structures (i.e. clusters), defined by the intrinsic properties of the environ; human actions are doomed to failure if they are contrary to the internal potency of the environ.

• Elimination of zigzags of clusters' development is possible, if resonantly excite the correct structures in a nonlinear environ, which are almost perfect, close to the attractors – the target of evolution. Resonance is an unusual mutual reinforcement of parallel efforts, and the effectiveness of small, but topologically correct impact.

• Configurationly proper unification of parts into a whole (structures of varying degrees of sophistication, i.e. 'all ages', in a complex structure – cluster) makes it possible to accelerate the pace of evolution as of a whole (i.e. cluster) and its constituent parts (i.e. cluster members).

• Sometimes to speed up the emergence and development of a cluster, one must create and exacerbate conflicts, resolve them, for example, including a cluster member with certain interests.

• Adherence to the circumstances – a component of the capacity situation. Any act of violence is excluded, but followence is allowed. Potential effect should not be looked for, one should not put any effort for independent action. Effect (of cluster formation) derives from the natural process, and the whole strategy comes down to learn how to find a process that is moving in the right direction. The appearance of the effect occurs naturally, by itself.

• The art of strategy is to find the soonest possible the weakest trends that tend to develop a cluster: highlighting them in the moment when they are barely there and begin to influence the continuous course of the circumstances before they could emerge and visibly show their efficiency.

• Managing the development of a cluster is possible through situational potential.

3. The Synergetic Approach on Cluster Formation

Based on the synergetic approach, authors suggest a block diagram of a non-linear positive feedback, which is advisable to base the system of agro-industrial clusters and individual clusters of the system, such as clusters of a 2nd generation (Figure 1).

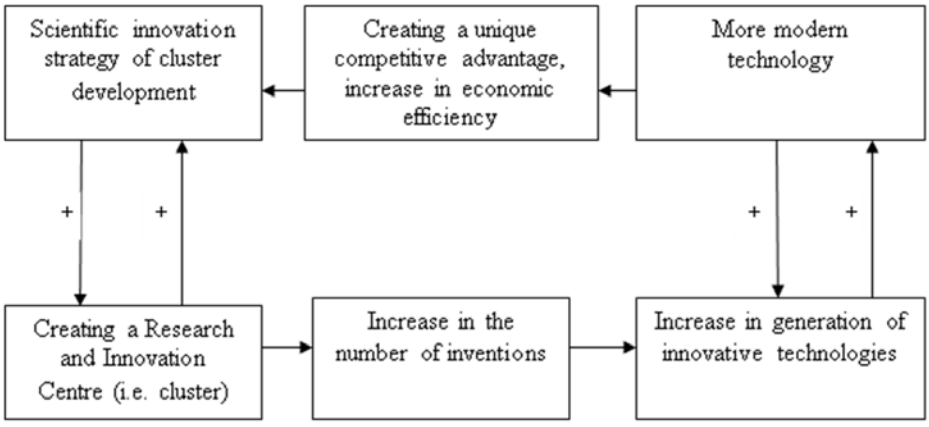

Figure 1. Block diagram of the nonlinear positive feedback in the system of agroindustrial clusters or cluster

Synergetic model of artificially generated cluster, based on innovative technologies, is shown in Figure 2. The latter is built on the principles of symbiosis, the positive and negative connections. The use of innovative

technologies and their symbiotic synthesis generates specific, but not abstract economic interests – benefits to the creation of industrial cluster for their potential participants. This leads to a fast and efficient self-organisation of a cluster. The principle of symbiosis is implemented in such a way that the output products, for example, of a participant 1 is the starting material (i.e. input) for the participant 2. Thus, technology of the 1st convert the waste into resources that revert to the process of the object 2. This demonstrates a positive feedback process, which is capable of generating ultrafast processes of hyperbolic growth and considerably improve the functioning of clusters.

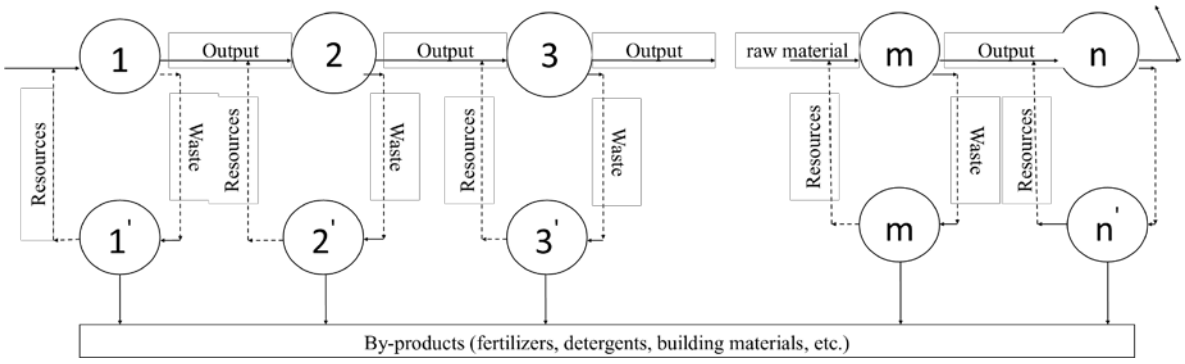

Figure 2. Synergistic model of a turbo-cluster, in a framewotk of technological perspective

Note: 1,2,3…m,n – numbers of production facilities - the technology of the main products;
1', 2', 3'... m', n' – numbers of production facilities – the technology of the finished product ready for recycling, reprocessing waste materials and by-products

It is crucial that the implementation of the cluster and its associated synergetic approach has the objective conditions in Russian agriculture [13,14,16].

Thus, the use of a synergistic approach with elements of Eastern worldview (i.e. the concept of 'situational potential', 'following circumstances', etc.), opens a new, unusual and paradoxical opportunities for the development of agro-industrial clusters in Russia.

4. Conclusion

Overall, the study of the synergetic approach to the development of agro-industrial clusters leads to several conclusions:

• Interconnected growth of research intensity and clustering in the world economies is a megatrend of development in the XXI century, which defines the civilized development in general. Russia cannot ignore this megatrend, or lag behind in development forever.

• Synergetic approach is appropriate to the development of agro-industrial clusters, as self-organizing forms of integration.

It is necessary to use three-way cluster formation: natural, artificial, and a combination of the two. The foundation of the cluster must be based upon innovative technologies, such as waste management in a variety of by-products.

• Heuristic synthesis of synergy and Eastern worldview seems productive in the theoretical and practical aspects.

• The formation of clusters is managabale by controlling the potential situation in which a cluster is formed.

• It is reasonable to adjust the modern definition of 'agro-industrial cluster' with characteristics of self-organization and synergy.

• The use of a synergistic approach enables to accelerate the emergence and development of clusters, considerably increase their efficiency.

• The implementation of ultrafast processes in clusters requires the clusters to be formed on the basis of the symbiosis, nonlinear positive and negative feedback. In each case, creating a cluster, one must find unique and distinctive forms of the implementation of these principles.

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